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THE PRACTICAL ENGINEER

VOL. VII. Philadelphia, January, 1904. No. 12.

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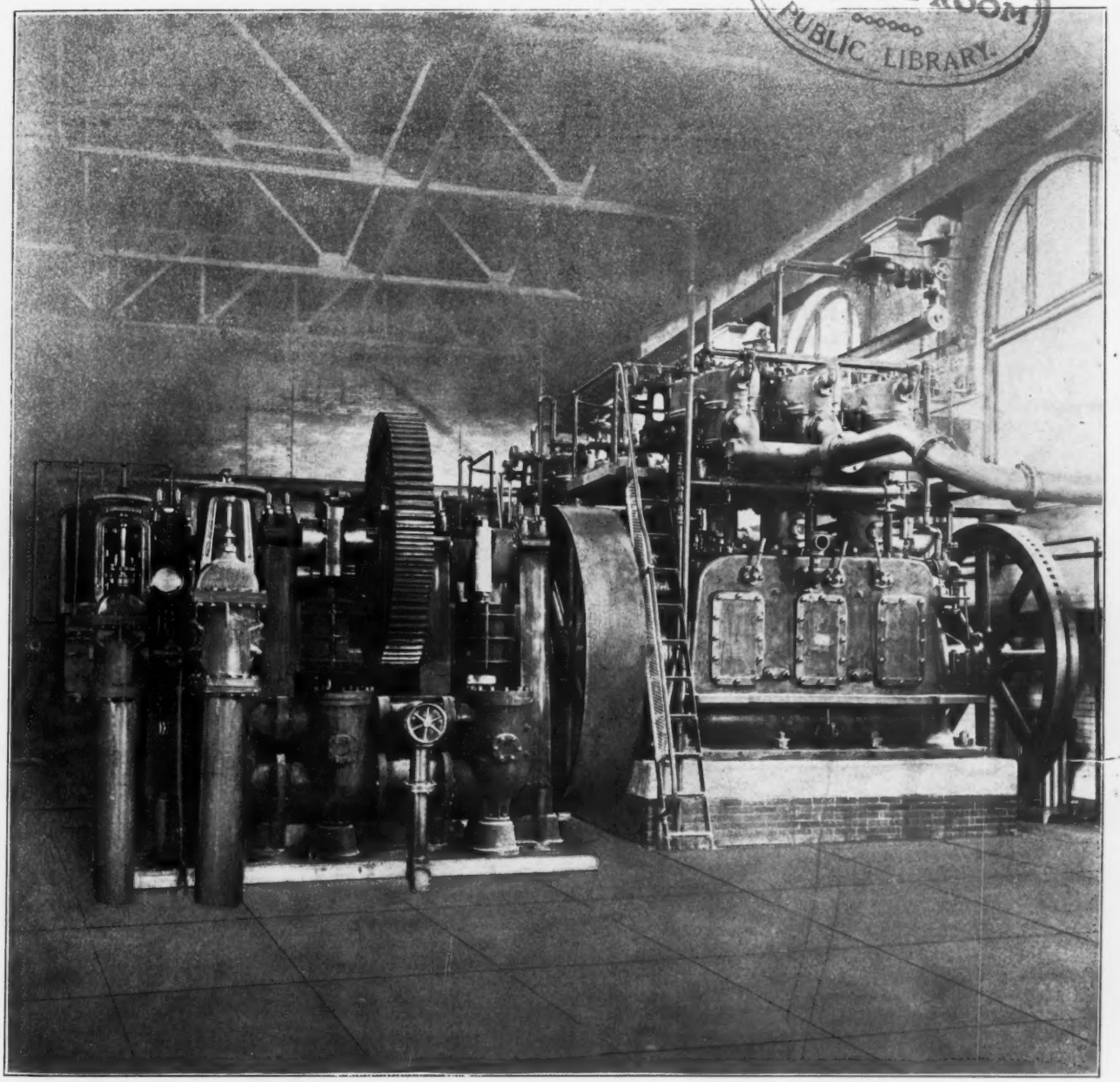

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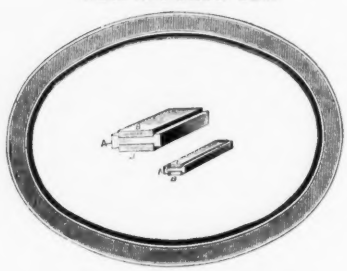

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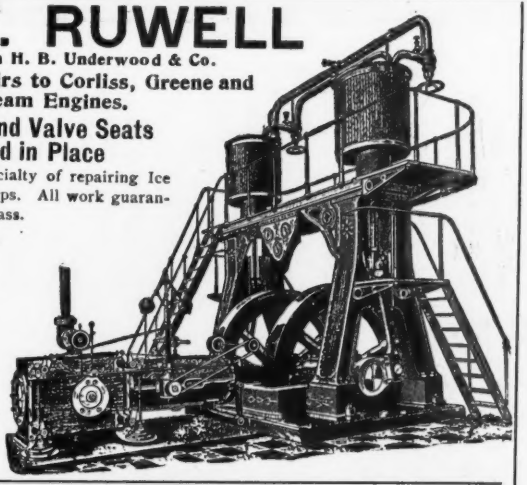

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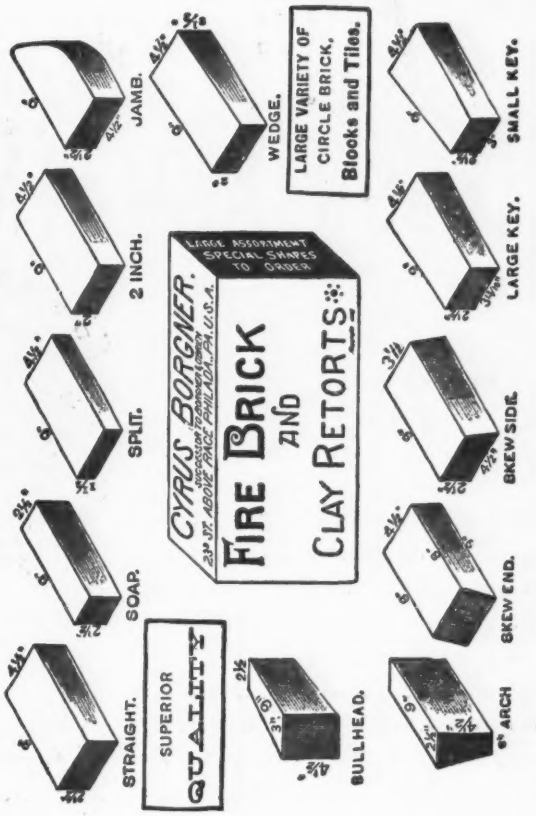

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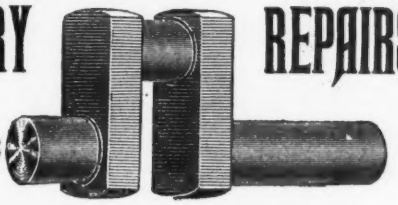

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Yours truly,
ALFRED LARSON,
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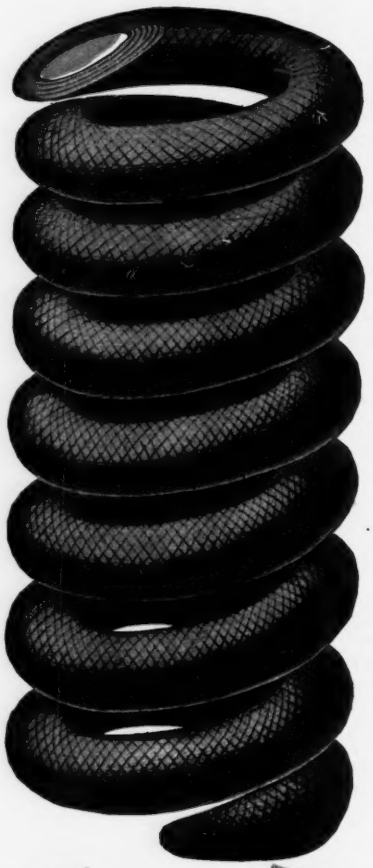

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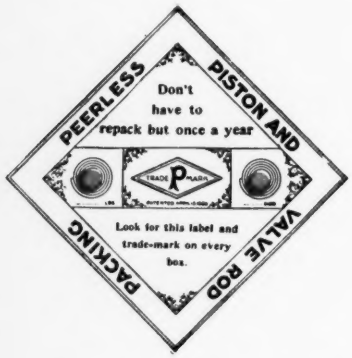

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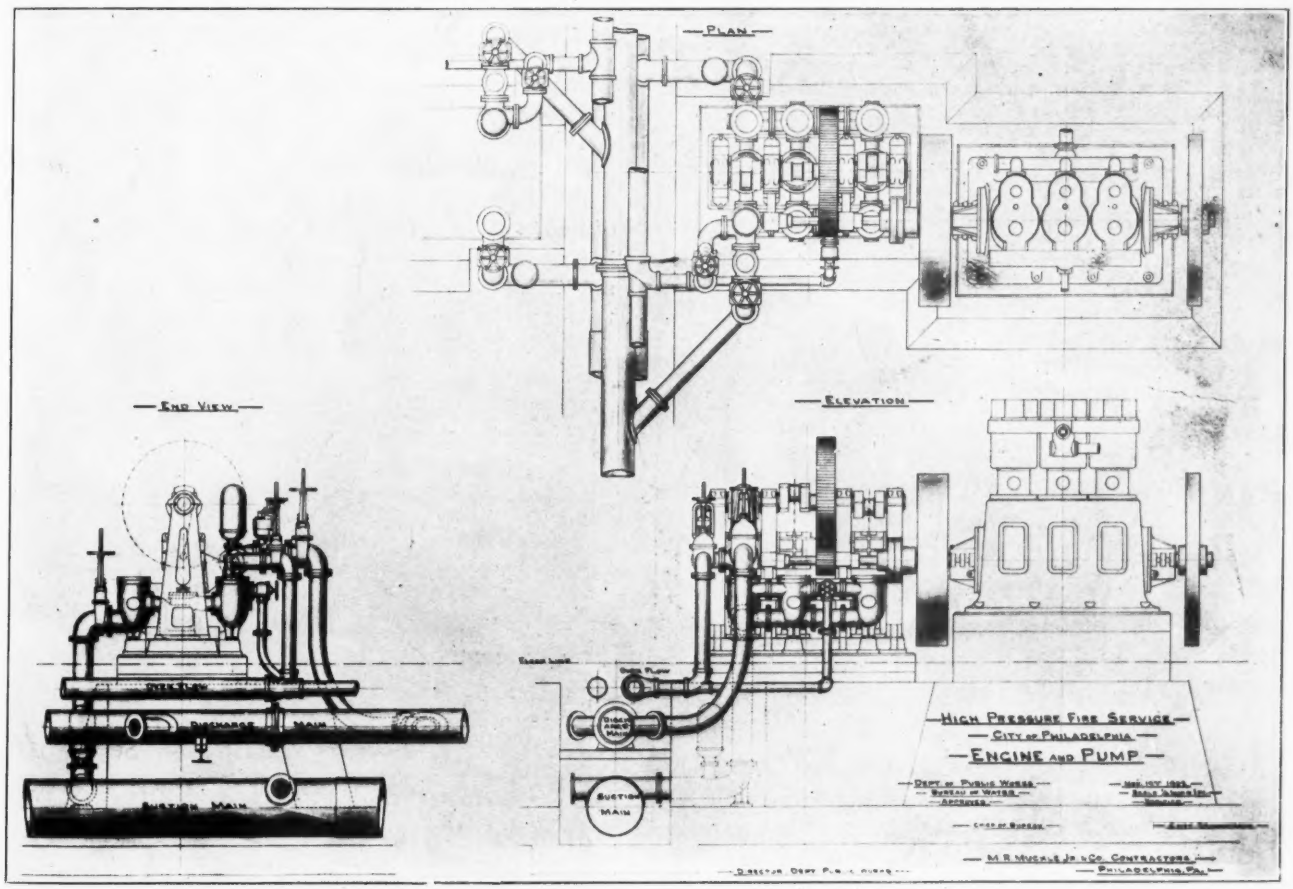
VOL. VII PHILADELPHIA, JANUARY, 1904 No. 12

A High-Pressure Pumping Station.

Philadelphia's Great Pumps and Engines for Fighting Fires.

The pumping station of Philadelphia which has just been completed is one of the most unique of any of its kind in the world. It is situated close to the Delaware River, at the corner of Delaware Avenue and Race Street, Philadelphia. This building is of massive construction, built of steel and brick, and contains nine enormous pumps—pumps that will render fire engines obsolete and useless wherever this water will reach. These pumps are able to send through the fire mains 16,000,000 gallons of water a day and generate enough power to squirt simultaneously four streams of water over the roof of the city's tallest building.

It is able to mass together and discharge floods under which no fire is supposed to be able to live for one-half hour. The new fire line has reduced the rate of insurance 15 cents on the $100, and when the pumping station is in full operation it will reduce the insurance rate ten cents more on the $100.

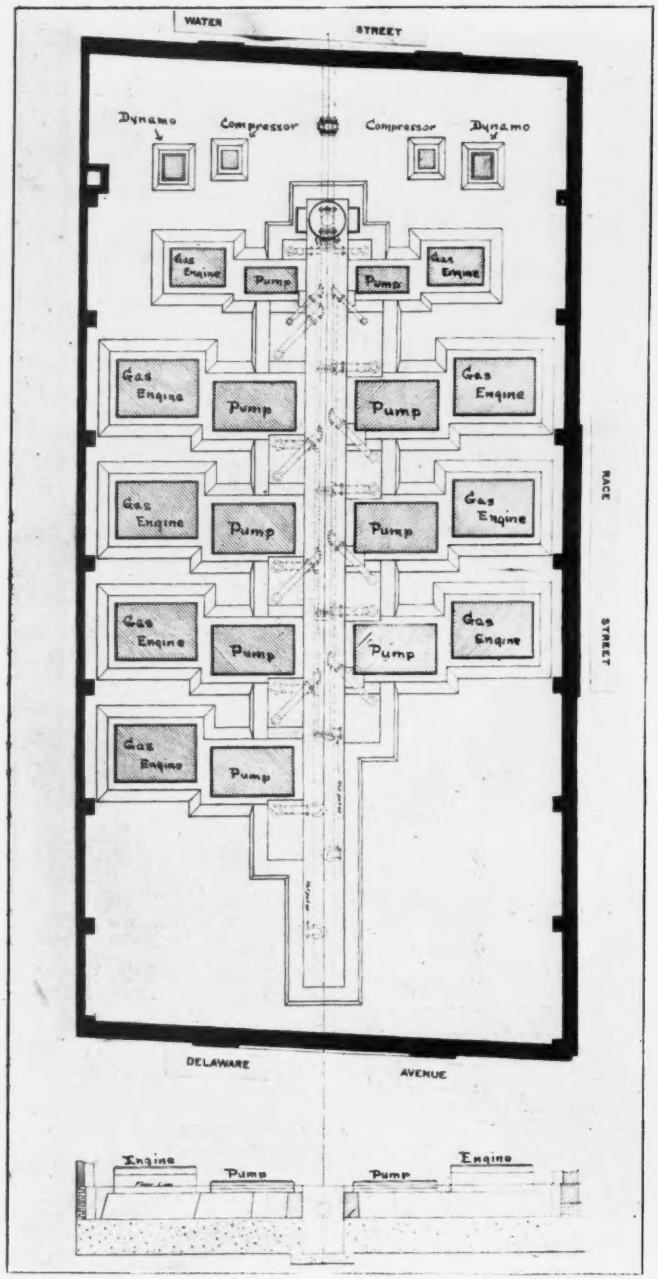


Plan and Elevation of Gas Engines and Pumps.

New York, Chicago, Boston, London, and Paris are watching this new pumping station, and if it shall prove a success they

will operate stations like it, as it represents the greatest advance in fighting fires that has been made up to the present time.

The pumping station is a one-story building, 72 feet by 140 feet, and its total cost will be $250,000. With its walls of white enamel brick it is light, airy, and spacious within. It has nine gas units or pumps of a total capacity of 2400 horse power, and these engines can be started from a state of rest

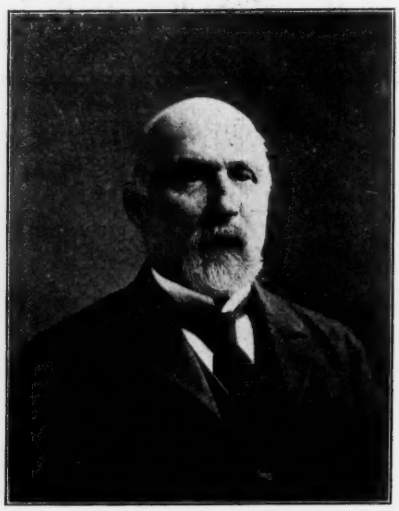


Arrangement of Engines and Pumps.

to full speed in the remarkable time of 20 seconds, and in one minute from the time the fire alarm is sounded they can deliver water at a pressure of 300 lbs. per square inch.

Two of these engines are small; they are each of 150 horse-power, and they each have a pumping capacity of 350 gallons of water per minute under a 300 pound pressure. The remaining seven units are of 300 horse-power each, and their pumps will each deliver 1200 gallons of water under 300 pound pressure per minute. The cost of each large engine complete was $22,000, and of each small one, $8,000.

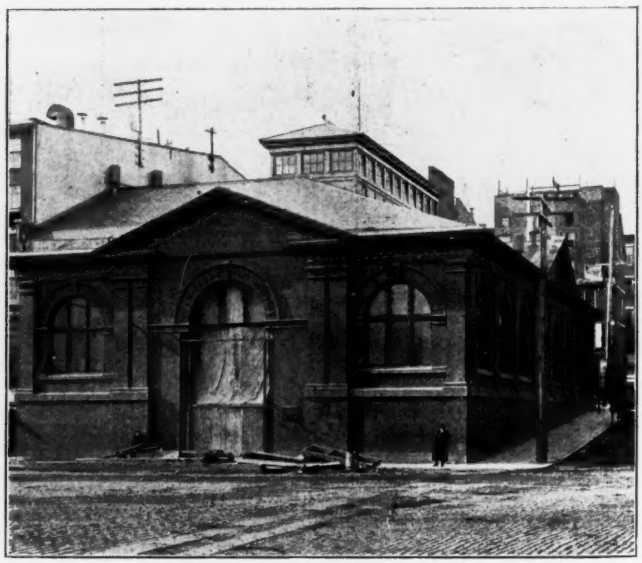
The pumps were especially designed for this station by the Dean Pump Co., of Holyoke, Mass. They are of the double



Mr. Frank L. Hand, Chief of Water Bureau.

acting triplex sort, the diameter of the pistons being 11½ inches, and they run at forty revolutions per minute, being geared down from the engine in the ratio of one to five, as the engine runs at 200 revolutions per minute.

The engines were built by the Westinghouse Gas Engine Co., of Pittsburg, Pa. They are of the four-cycle type, each engine having three cylinders connected at 120 degrees to the main shaft, which are directly connected by gears to the pumps. By the four-cycle type is meant that the piston makes four strokes for each impulse. The first cycle is the descent of the



Exterior of Pumping Station.

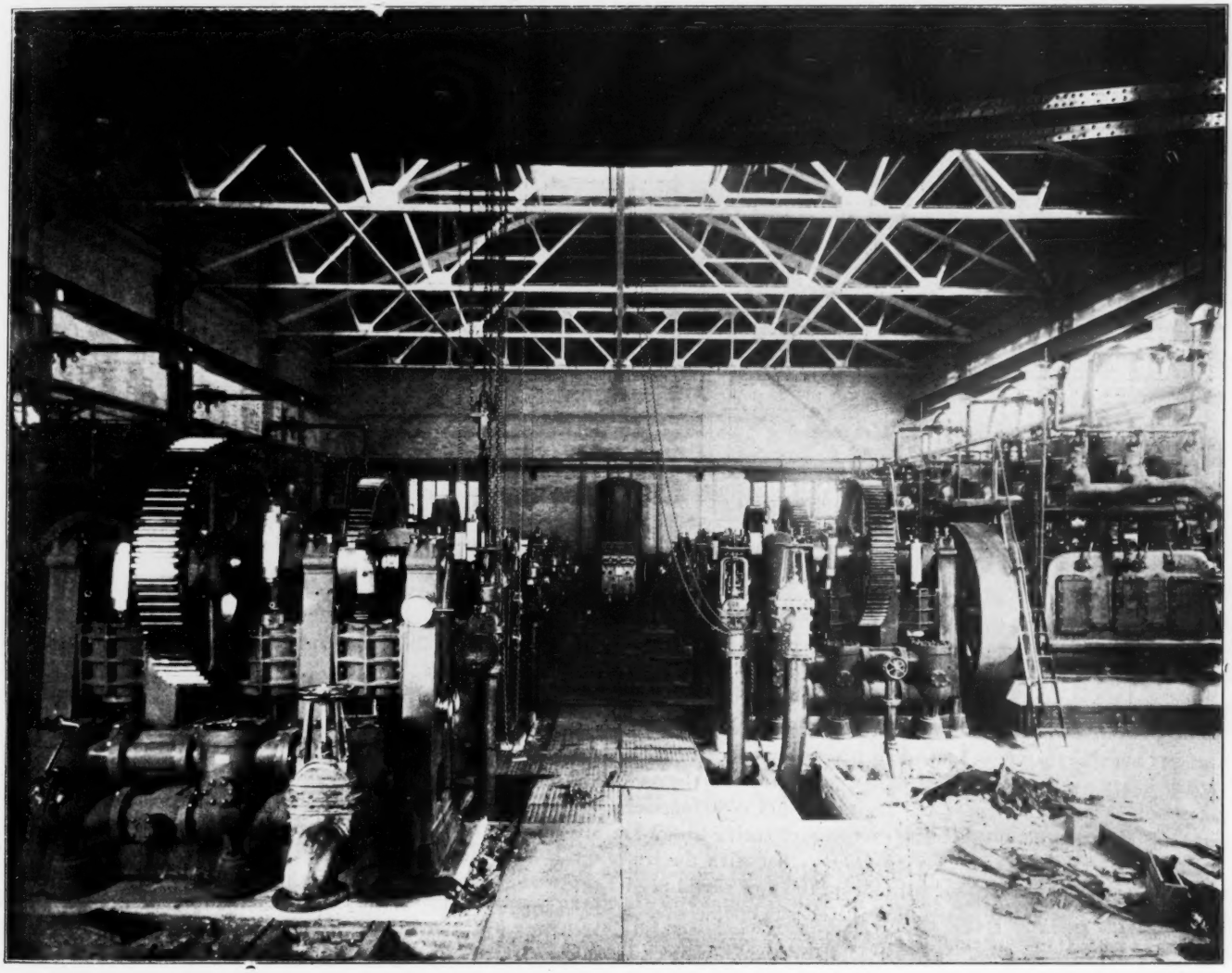
piston, which draws in the air and gas. The second cycle is the piston's ascent, compressing the mixture. The third cycle descending, ignites the air and gas, giving the power to the engines,

and the fourth cycle, ascending, discharges the ignited mixture into the exhaust pipe.

The engines are started by the use of compressed air. The compressed air, which is always on hand, is stored up in eight large cylinders at a pressure of 200 pounds per square inch. After these engines have attained a sufficient speed, the gas and air are turned on and ignited when the compressed air is turned off. The mixture which is introduced into each cylinder consists of six parts of air to one of gas. The sparks for the engines are obtained with electricity, and on account of the importance of this, so that there shall never be a failure of the electric current, there are three ways to get a current, so that in an emergency should one way fail, another may be turned to, and should that fail, there is a third and quite infallible resort. The first current that may be used is the outside Edison current, which is cut down from 220 volts to 110 volts by means of a rotary transformer. The second current is the station's own, from its own dynamo. The third is the infallible resort, the station's storage battery, which consists of a few Edison jars that are capable without any renewal of keeping the engines going for four months.

The two small engines, besides running the pumps attached to them, also run the dynamos and air compressors. One of the small engines can be made to drive its air compressor and dynamo independently by throwing a clutch which throws its pump out of service. The two dynamos are of the Westinghouse type, each having a capacity of 7.5 kilowatts, and the compressors, furnished by the Rand Drill Co., compresses the air into large cylinders in which it is stored, so that sufficient air under a pressure of 200 lbs. is continually available to start any or all engines.

Everything within the plant is duplicated, so that there is no danger of failure. As it is very important that the cylinders should not overheat, there are three sources of water-supply to the jackets around the cylinder. Two sources of water-supply are connected to different city mains, and the third source is the fire line itself, in which there is always a pressure of water maintained from the city's reservoir.



Interior of Philadelphia's High-Pressure Fire Service Station.

The pressure of water that the pumps maintain can be regulated to the hair. Thus it may be one minute 300 pounds, the next 100, the next 250 pounds, as suits the engineer. This is done automatically by means of an electric motor. A motor is connected to the main valve and is geared to it, so that by regulating a switch any pressure can be secured immediately up to 300 pounds per square inch. So that there will not be a greater pressure than 300 pounds per square inch on the pumps,

there are duplicate spring valves which open the water line to the overflow, when there is more than the required pressure, but which are always closed when the line is under that pressure.

Gas is used rather than steam in this huge pumping station for economy in cost, in space, and in time. With steam the fires would need be kept going all the time, and even then full speed could not be generated quickly. As the station is situated in the very densely populated business section, it saves valuable space that would be taken up by coal sheds and boilers, and tracks for coal cars.

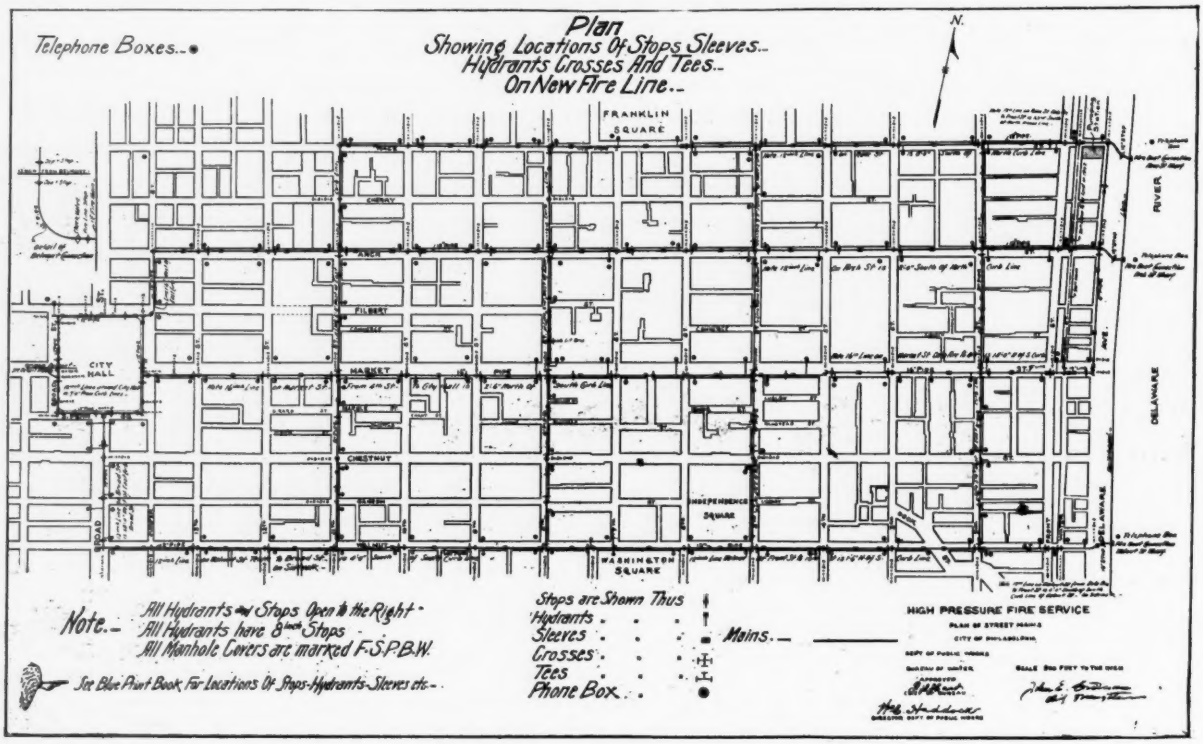
The power now comes to the station through one simple pipe 30 inches in diameter, and with this pipe each of the nine engines has its separate connection. It is estimated that to run steam engines like these gas engines would cost for fuel alone 25 per cent. more, this being exclusive of such additional expense as more men and more space, together with the tremendously important fact that with steam the fires would need to be kept always going, whereas with the gas engine everything may lie cold and motionless till an emergency comes.

On the main gas line of each engine there is a gas pressure regulator. This is used for the purpose of always keeping the gas pressure constant, as the pressure on the main gas pipe is continually varying and the amount of charge, and therefore the setting of the valves depends upon this pressure.

Ths pipe line which the pumping station supplies is nine miles long. The pipes, having diameters of 16, 12, and 8 inehes, were all designed by the Bureau of Water under the supervision of Chief Hand, who also drew up the specifications for the pumping station. They are all specially made, of extra heavy thickness, and all the fittings, including fire plugs, are of special design. The total weight of this pipe is 6,500,000 pounds and the total weight of the various special fittings is 850,000 pounds, having cost $355,000.

The pumping capacity of this station is 10,500 gallons per minute, and as the pumping capacity of a fire engine in actual service is only about 250 gallons per minute, this station, with its pipe line, will do the work and do it better than 40 engines have heretofore done it.

M. R. Muckle, Jr., and Co. of Philadelphia, are the engineers who installed the gas pumping plant, and together with Mr. Frank L. Hand, Chief of Water Bureau, the success of the plant is due.



Plan of Philadelphia's Fire-main System.

A Motor Which Will Run Under Water.

A water-proof motor which operates without interference, although entirely submerged, has just been installed in a large store in Chicago. While enclosed motors have been made use of for some little time in places where the machinery must be protected from dust, this, probably, is the first motor that was built to run under water. This motor is one hundred horsepower and is connected to a duplex pump. It forms part of a sprinkler system which extends to all parts of the store. The electrical wires are led into the case of the motor through pipes which are screwed into it. Ventilation to prevent the windings from burning out is secured by means of a fan which keeps a circulation of air moving through the parts coming in at one side of the casing and being discharged through pipes at the other side. The construction of this casing is so tight that a stream of water can be played on it or it can be completely submerged without any damage or interference with its operation. The water in the pipes of this installation is maintained at a pressure of one hundred pounds per square inch by automatic means, the motor being started when the pressure falls a few pounds below one hundred and is automatically stopped when the pressure exceeds one hundred pounds per square inch.

Machine Screw Threads and their Properties.

Square, ½V and V Threads. Right-hand and Left-hand Threaes.

By Oscar C. Schmidt.

Of all the pieces of machinery, with which the engineer has to do, the screw is perhaps the most often used. In a steam engine alone, there are a score or more screws used in holding on the cylinder head and valve chest, a number hold down the engine to its bed, screws of various kinds are used to regulate the packing boxes and adjust the mechanism to take up the wear

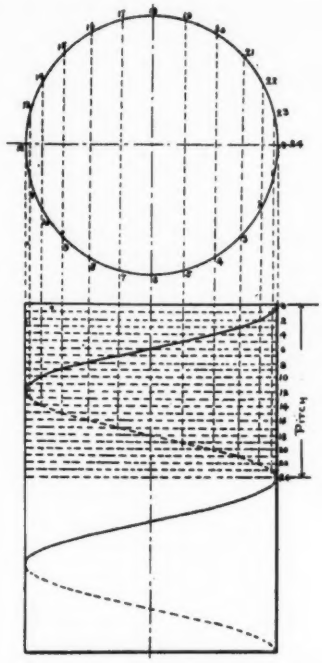


Fig. 1.

in the cross-head and crank-pin boxes, as well as the many other smaller screws which hold the valve motion and governor parts in place. In any machine shop there can be seen the ever-present screw performing its many duties. Besides its principal use of holding different parts of machines together, its next important use is to transmit motion. This is illustrated by the movement of a carriage along the bed of the lathe, which is done by means of a lead screw. The feed of a drill as it silently and almost imperceptibly bores its way through the hardest iron, is done by means of a screw, and so

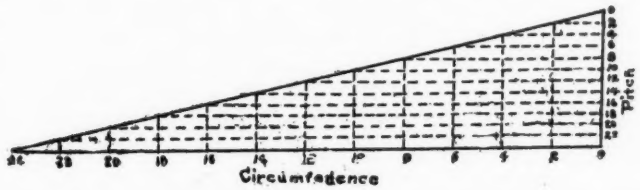


Fig. 2.

the examples of its use may be magnified and enlarged. Another important use, that the screw has, is the transmission of power. This is clearly illustrated in the screw-jack or a mandrill press, where by almost the slightest touch of the hand it will cause this to be transmitted until it becomes a mighty power.

All machines, however so much they are complicated, are nothing more than a combination of simple machines. These are again sub-divided, until it is found that all work is transmitted by the use of two or three simple mechanisms, of which the inclined plane, as represented in the screw, is one.

Upon analysing the screw thread it is found that all threads have the same general curve, which is known as a helix. The simplest way to think of a helix is to consider it as the curve formed by a string wrapped around the circumference of a cylinder. There are two things that must be known before a helix can be drawn, and they are the diameter and the pitch. The pitch is the axial distance that a thread traverses with each revolution of the cylinder. That is, if a thread or helix has a pitch of one inch, the screw will enter the nut or move in an axial direction one inch for each complete revolution.

The method of drawing a helix or screw thread is illustrated in Fig. 1. The diameter of the thread is the diameter of the cylinder, and the pitch is assumed as any axial distance. The method then is to divide the circumference of the cylinder into the same number of parts as the pitch is divided. Through each point along the pitch draw horizontal lines. From each point on the circumference of the cylinder drop vertical lines until the line from point *one* intersects the horizontal line *one;* the vertical line from *two* intersects the horizontal line *two*, etc. When these points are connected, they form the curve required.

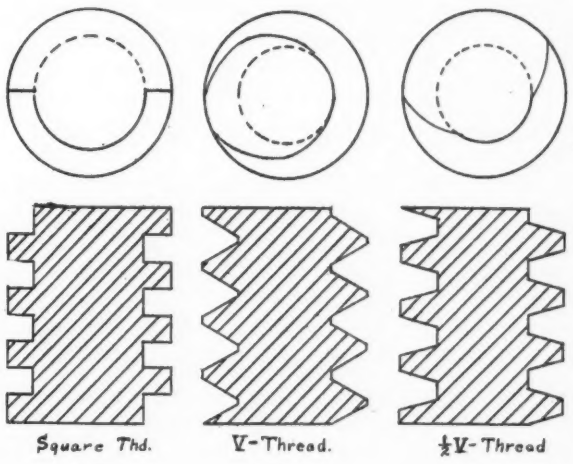


Fig. 3. Fig. 4. Fig. 5.

To illustrate that the screw is an inclined plane see Fig. 2. It is obtained by opening the cylinder at some point and laying it out on a flat surface. It is called the development of the cylinder. It will be noticed that the figure is a right-angle triangle whose base is the circumference of the cylinder, and whose height is the pitch of the screw, the hypothenuse being the true length of the thread. As a screw always moves a distance equal to its pitch with each revolution, the work done by a screw is proportional to its pitch; that is, the smaller the pitch for any given diameter of thread, the less slant will the hypothenuse of the triangle have and the less height a body would be lifted in pushing it up this inclined plane. Threads are often used to transmit motion, so that the pitch is made great or small depending on the conditions.

There are three kinds of machine threads used in general practice throughout this country: the square thread, the V thread and the ½ V thread. The square thread is used to transmit motion and power, and is never used for fastening

The same is true of the ½ V thread. The square thread and the ½ V thread have very nearly the same uses, except that wherever a clutch must be thrown in or out of gear, when the screw is in motion, a ½ V thread is used. A square thread, if used for the same purpose, would soon have its square corners knocked off, so that in a ½ V thread the sides are slightly inclined to obviate this difficulty. The V thread is entirely used for gripping and holding different parts of machinery together, as its efficiency to transmit motion or power is very poor, and when once screwed tight it will not run back or loosen unless the pitch be very great. Without considering the strength of the thread, the finer the pitch of a V thread the better will be its binding qualities; for the same reason that the smaller the taper that a wedge has the less likelihood there is for its working loose.

Fig. 3 represents a section of a square thread showing its profile; Fig. 4 represents a section of a single V thread, and Fig. 5 represents a ½ V thread.

These profiles, or true shape of the thread, all bear a certain relation to the pitch of the thread. The shape of a square thread is square as its name signifies, and with a single square thread its width and depth are each one-half the pitch. In a ½ V and V threads the depth of the thread is $\frac{65}{100}$ of the pitch. These profiles are shown in Fig. 6.

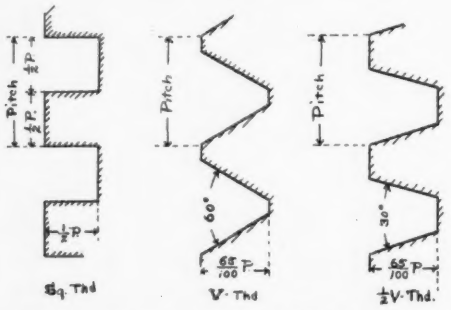


Fig. 6. Profiles of Square, V and ½V Threads.

In the construction of a square and ½ V thread there is no rule that is generally used which regulates the diameter and pitch, as each are used for varying conditions. The V thread is always used for the same purpose and hence all bolts and nuts are cut to a standard. In the earlier days of machine shop practice each thread was cut a different diameter and pitch, so that if a bolt was to be replaced or a nut was lost, each one had to be cut to order. As the use of machinery increased rapidly this became such a difficulty that a standard was adopted and is known as the Sellers or U. S. Standard, so that all one has to do is to order a bolt or nut of a certain diameter and the thread will be sure to fit.

The accompanying table shows the relation of the different pitches of the threads for different diameters of the thread; the word pitch here meaning that there are a certain number of threads per inch, which is the usual way of designating the pitch of a V thread. For example, a bolt or hole one inch in diameter would have eight threads to the inch. As all standard V threads have single threads, this means that the threads have a pitch of ⅛ of an inch, or the bolt or nut would have to be turned eight times to move axially one inch.

Threads are classified according to the way the threads run ou nd the circumference. They are divided into right-hand and left-hand threads. A right-hand thread is one that, when the screw is revolved in the direction in which the hands of a clock move, it enters the nut, considering the nut fixed. A left-hand thread is one which must be revolved in the opposite direction to the movement of the hands of a clock to make it enter the nut.

Threads are usually made right-handed. Standard V threads are right-handed and therefore all bolts and nuts have right-

Screw-Threads, United States Standard.

Diam.	Pitch.	Diam.	Pitch.	Diam.	Pitch.	Diam.	Pitch.	Diam.	Pitch.
¼	20	⅜	10	1¼	7	1 15-16	5	2 13-16	3½
5-16	18	13-16	10	1 5-16	6	2	4½	3	3½
⅜	16	⅞	9	1⅜	6	2¼	4½	3¼	3½
7-16	14	15-16	9	1½	6	2 5-16	4½	3 5-16	3½
½	13	1	8	1⅝	5½	2⅜	4	3⅜	3¼
9-16	12	1 1-16	7	1¾	5	2½	4	3½	3
⅝	11	1⅛	7	1⅞	5	2¾	4	4	3
11-16	11								

hand threads. V threads having the same dimensions as standard threads, are sometimes made left-handed for special purposes as the end of tie-rods which are connected to a turnbuckle, the functions of the turnbuckle being to draw together or push apart the two rods with which it is connected, and to do this one thread is usually made right-handed and the other left-handed. In square and ½ V threads, left-handed threads are often met with, as they are usually used for performing some special movement in a machine.

Screw threads are also divided into single, double, or triple threads. Double and triple threads are used with square and ½ V threads when a large pitch is desired without increasing the diameter of the thread. As the depth of a thread depends upon the pitch and not the diameter, it can be seen that there is a limit to the depth of the thread and therefore the pitch, as a thread, which has a large pitch, would enter the body of a small bolt so far as to weaken it. This difficulty is obviated by making the threads double or triple.

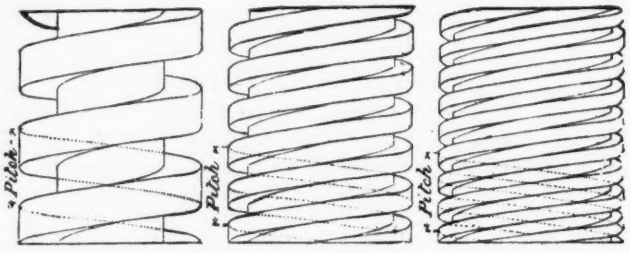


Fig. 7. Fig. 8. Fig. 9.

By a screw having a double thread is meant that the screw has two threads running parallel to each other and having the same pitch, the profile of each thread being one-half that of a single thread; the sum of the two threads equalling that of the single thread.

A triple thread is one having three parallel threads and a quadruple thread is one having four parallel threads. Fig. 7 represents a single square thread, Fig. 8 represents a double square thread, and Fig. 9 represents a triple square thread, all of which are right-handed threads.

The Use of Higher Pressures.

By R. T. Strohm.

The past half century has shown a remarkable rise in the pressure of steam used in ordinary work. In 1850 a pressure of twenty pounds per square inch was considered very fair practice; but twenty years later such a pressure would have been laughed at, while in the closing years of the past century pressures of from 150 to 250 pounds were not uncommon.

Perhaps the main reason at first, for increasing the pressure of steam used in engines, was to increase the horse-power, for

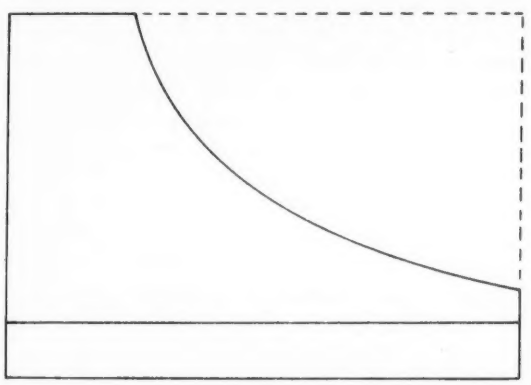


Fig. 1.

with low-pressure steam the engine would need to be inordinately large and cumbersome to produce comparatively small horse-power. But the additional advantage of using higher pressure lies in the fact that the steam consumption of the engine is thereby reduced and its economy therefore increased in the same proportion, other things being equal, for the economy of the steam engine is measured by the number of pounds of water required per horse-power per hour. Of course, to make comparisons fair, they should be reduced to the same conditions of pressure and quality of steam supplied.

To show what the saving due to an increase of pressure may be under ideal conditions, refer to the first illustration shown herewith. Fig. 1 illustrates a theoretical diagram from an engine having no clearance, using steam of 150 pounds absolute pressure with four expansions, the scale of pressures being 75 pounds to the inch and the scale of volumes $1\frac{1}{3}$ cubic feet to the inch. The expansion curve is assumed to be an equilateral hyperbola, and the back pressure is taken as 20 pounds absolute.

By calculating the work done, during a single stroke of the piston, from the diagram, it is found to be 39988.8 foot pounds, and this is accomplished by one cubic foot of steam. By reference to a steam table, it is found that a cubic foot of steam at 150 pounds absolute pressure weighs .337643 pound. Consequently the work which one pound of steam at this pressure and under these conditions would perform is 39988.8÷.337643 =118435 foot pounds.

Next, refer to Fig. 1 again and suppose all conditions to be just the same as in the case previously shown, except that the scale of pressures is 50 pounds to the inch, or in other words, the engine works under a pressure of but 100 pounds instead of 150 pounds as in the foregoing example. In this case the work done per cubic foot of steam used is but 22819.2 foot pounds.

Now, a cubic foot of steam at 100 pounds absolute pressure has a weight of .230293 pound, and as a consequence, the work done per pound of steam used under the stated conditions must be 22819.2÷.230293=99088 foot pounds. This leaves a balance of 118435—99088==19347 foot pounds of work in favor of the steam at the higher pressure.

Such a result is to be expected, however, since the higher the pressure of steam the greater the heat it contains, and consequently the larger the amount of work which it should be capable of doing. The difference in total heat between a pound of steam at 150 pounds pressure and the same quantity at 100 pounds pressure is 1191.200—1181.866=9.334 heat units. From the calculations in the previous paragraph, the higher pressure steam gave 19347 foot pounds of work more than that of lower pressure, which is equivalent to 19347÷778=24.867 heat units. In other words, we added 9.334 heat units more to a pound of steam at 100 pounds pressure, to make its pressure 150 pounds, and thereby obtained 24.867 heat units more from it in actual work than could have been obtained from the same quantity at 100 pounds pressure, working under the same conditions. The net gain is therefore 24.867—9.334=16.533 heat units, which is attributable to the increase in pressure.

The above results do not mean to indicate that more heat is obtained from the steam than is put into it. That would be utterly impossible. But it does show that by the addition of a slight amount of heat it is possible to make a much larger proportion of the total heat available for useful work. In other words, it is economical to use high-pressure steam wherever possible, because as shown, each pound of steam used will produce a greater amount of work.

The steam consumption may be decreased also by increasing the ratio of expansion of the steam—for, the greater the number of expansions the larger the work area represented by the diagram. This is clearly shown in Fig. 2. The solid outline represents the work area due to expansion of steam when the cut-off occurs at half stroke. That is, $gm=2\,ga$, or the number of expansions is two. If, now, the number of expansions is increased to three, so that $gn=3\,ga$, then there is added an area *bcdf*, shown in dotted outline, which represents an extra amount

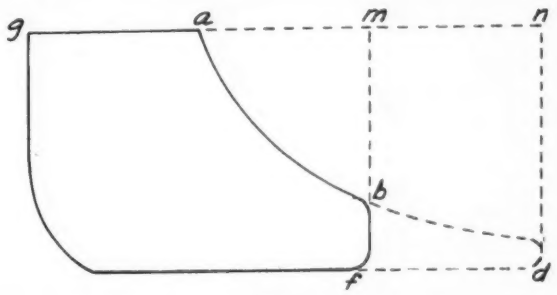


Fig. 2.

of work obtained without increasing the quantity of steam used, since there is no alteration of the volume of steam previous to cut-off. Manifestly, then, the increase of ratio of expansion has made a greater amount of work available from the amount of steam used, and it is evident that the greater the ratio the larger becomes the additional area *bcdf*, and consequently the less the steam consumption per unit of power developed.

The ratio of expansion may be increased by increasing the initial pressure and shortening the cut-off. The final volume will thus remain the same, but the initial volume will be less

than before, and consequently the number of expansions will be greater. By properly adjusting the cut-off the terminal pressure may be kept unchanged, and thus no more heat thrown away in the exhaust than formerly.

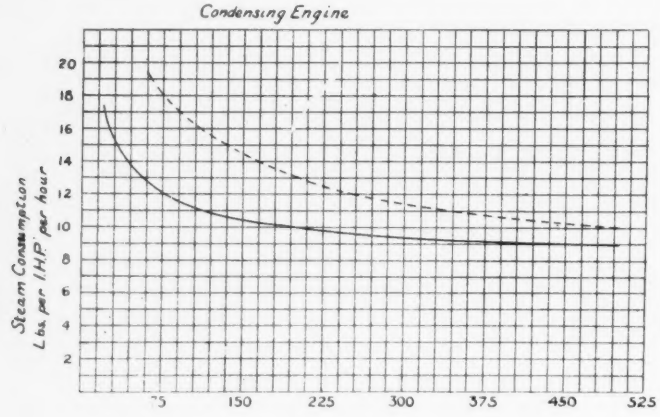


Fig. 3.

In the preceding discussions ideal conditions have been assumed. That is, the steam has been supposed to follow the equilateral hyperbola as an expansion curve. No condensation due to the cooling effect of the cylinder has been taken into account. Leakage of any and all kinds has been disregarded. These are conditions which do not obtain in actual work. Consequently the gain in economy is considerably less than is apparent from the figures. But there is undoubtedly a gain.

When the ratio of expansion is increased in a single cylinder, the ratio between the initial steam volume and the amount of cylinder surface is lessened, and there is a consequent greater loss by cylinder condensation. And so there is a point beyond which expansion in a single cylinder must not be carried if maximum steam economy is to be observed.

With the compound engine and multiple-expansion engines, the ratio of expansion can be greatly increased by the successive expansion in two or more cylinders, the range in each being only moderate and the losses therefore reduced in proportion. So that a high-initial pressure and an early cut-off may be employed in the high-pressure cylinder, enabling a great ratio of

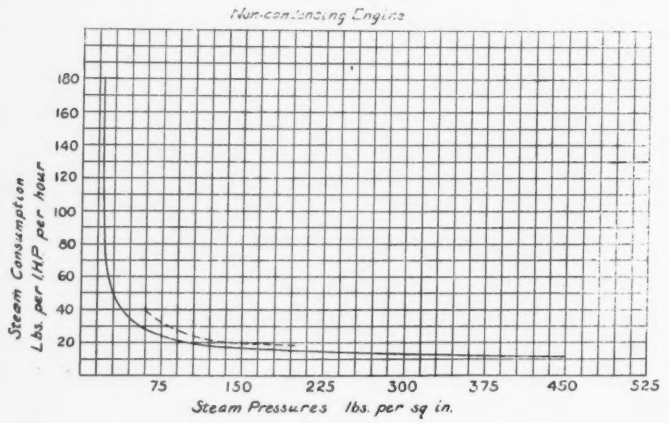


Fig. 4.

expansion. And this causes a corresponding decrease in steam consumption per unit of power developed.

It is not possible to state any general formula or rule giving the rate of increase in economy due to increased ratio of expansion, since the initial and final pressure of the steam, the type of engine, and the piston speed, all effect the steam consumption, even where the number of expansions remains constant. However, it is possible to show the rate of increase due to raising the pressure, as illustrated in Figs. 3 and 4. The curves shown solid are for the ideal engine, and consequently are valueless, inasmuch as they do not pertain to actual results obtained. But they do show what the perfect engine might accomplish, and they thus form a basis of comparison for results which have been secured in practice. The curves shown dotted are plotted from the results of tests made upon actual engines at various steam pressures, the results showing highest economy being taken in plotting the curves. As can be seen, the actual curve approaches the ideal as the pressure rises, indicating that as the pressure is increased the economy of the actual engine approaches more nearly that of the ideal engine.

It is extremely interesting to note, also, the relative savings effected by increasing the initial pressure and lowering the exhaust pressure an equal amount. Refer to Fig. 5. The card in solid outline represents a diagram from one end of a simple non-condensing engine. Suppose that the pressure is increased twelve pounds, and cut-off shortened so that exhaust will occur at the same pressure as before. Then the steam line will be raised to the dotted position and an extra amount

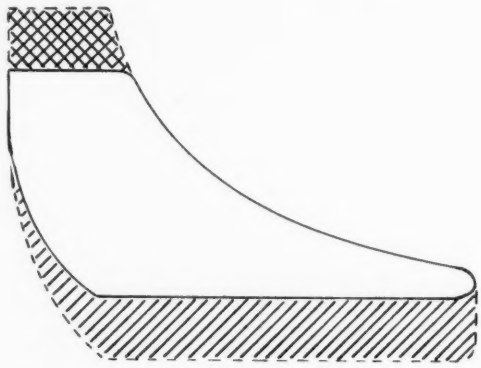


Fig. 5.

of work will be obtained, represented by the area shaded with double cross-section lines. If, on the contrary, the initial pressure be left unchanged, and a condenser added, so that the back pressure is reduced twelve pounds, then the area representing increased work will be that shown by plain cross-sectioning. A comparison of the two areas, which are of course to the same scales, makes plain the gain to be derived from reducing the back pressure in a non-condensing engine, rather than by increasing the initial pressure.

Wind Driven Generators.

For more than two years two small factories, one near Leipsic, and the other near Hamburg, have been satisfactorily driven by windmills, which are also used as a means for generating electricity for lighting purposes. A German paper states that the windmills have a diameter of sixteen and eighteen feet respectively, and are mounted on the roof of the works. To insure reliability the windmill itself has no moving parts, the speed regulation being obtained by turning the windmill so as to vary the angle under which the wind impinges upon the sails, which are built of steel sheets. This is performed by a small auxiliary wind motor, and it is said to be done so quickly

and accurately that the voltage of the dynamo remains practically constant throughout the range of ordinary wind pressures. An automatic switch cuts out the battery connected in parallel with the dynamo as soon as the wind falls below a certain point. In one of the cases mentioned, the battery may be divided into two parallel groups when it is necessary to utilize unusually low winds.

More About Progress.

By W. H. Wakeman.

I wish to introduce another comparison between high and low-speed engines, in order to continue the investigation begun under the above title.

A certain manufacturer found that owing to increasing prosperity it was necessary for him to provide a larger shop in which to continue business. He bought land in a suitable locality, erected a brick building, and equipped it with modern machinery, including what he considered to be an up-to-date engine. It was of the high speed type, with a stroke about one and one-half times the diameter of cylinder, and its speed was 300 revolutions per minute. This engine was built by a firm who recommend their product for supplying power wherever it is needed, which of course includes mills, shops and factories.

It was installed in due form, and duly started, after which it turned the shafting for a few months, but its speed was unsatisfactory, although there was nothing in this shop calling for extraordinary accuracy in this respect. It was frequently necessary to shut down during working hours, to adjust some of its parts, or for other causes, causing annoyance to the employes and loss to the owner.

Finally the proprietor became disgusted, bought and installed another engine, but did not remove the first one until months afterward. The stroke of this was a few inches more than two and one-half times the diameter of cylinder, and it revolved 36 times per minute. From this description, which contains all data necessary for the comparison intended at this time, it will be noted that this engine was a "regular old-timer," and it may not be out of place to remark that previous to its installation in this plant, it worked at the same speed for many years in another place, and probably would be there yet, if it had been large enough to carry the heavy and increasing load due to extension of business.

From the first day on which it commenced work in its new quarters it proved eminently satisfactory, supplying power whenever wanted, giving speed of shafting that is steady enough to answer every purpose in that place, requiring but little attention, calling for practically no repairs for many months, while the cost of lubrication is very low.

The consequence is that if any venturesome salesman should try to sell the owner of that engine, a modern, up-to-date high-speed machine, he would meet with a very cold, or a very hot reception, according to local conditions.

Here is a case where a standard high-speed engine was pronounced a failure and an old-fashioned machine installed in the same building, operated for the purpose of driving the same machinery under like conditions, answers every requirement and therefore is satisfactory.

Does not this appear to show that new types of engines embodying principles that are theoretically correct, are not always equal to those having less pretentious names, but which will keep a shop in operation every day in the year, with the least possible trouble and no annoyance whatever?

Statements to the effect that engines driven at much higher speeds give satisfaction in other places, or that one of them could be used in this place under different management, have little or no weight as arguments in this matter, for conditions must be considered as they are found in practice, and not as we might wish to have them in order to suit our convenience.

This steam user is decidedly of the opinion that the high-speed engine for factory use is a failure, and many others are of the same opinion, proof of which is found in the fact that a certain firm which formerly manufactured and sold hundreds of these machines, now supply their customers with others of slower speed and longer stroke, which prove much more satisfactory.

Some time ago strong efforts were made by several engine builders, to flood the market with enclosed engines, so that when a man bought one of them, he had a cast-iron box into which he admitted steam, and when the conditions were favorable a shaft protruding out of the box, carrying a fly-wheel, began to revolve.

If this engine bounded, or lost motion caused excessive noise of any kind, there was nothing to do but turn on steam when it was time to start up, and shut it off when the run was finished, unless the whole thing went to pieces before it was time to shut down. It was claimed that as it was impossible to make any adjustments in the ordinary way on these engines, they were much superior to others, hence should have an extensive sale. This was proper, provided the engineer in charge did not know enough to take care of an engine, but otherwise there was no advantage in the plan, for although one of these engines might not need keying-up as often as some other kind, when it did need it, the best engineer in town could not do it, therefore the whole type of engine was pronounced, not a brilliant success, but a flat failure, hence their production was not in the line of progress.

The engine previously referred to as revolving 36 times per minute, had a fly-wheel 16 feet 6 inches in diameter, therefore the rim speed is the circumference multiplied by the number of revolutions per minute, and $16.5 \times 3.1416 \times 36 = 1{,}866$ feet per minute, or 31 feet per second. Unless the rim of such a wheel is very heavy, the speed of crank shaft will not be uniform owing to the impulse given at the beginning of a stroke, and the low pressure at the end of it, (assuming that the cut-off is automatic), but this irregularity may be nearly overcome by increasing the speed of said wheel. This starts investigation concerning the safe limit of fly-wheel speed. Haswell states it at 80 feet per second, and it is well to remember that making the rim heavier does not make it safer, as the added weight increases the centrifugal force accordingly.

Of course it is absurd to limit the speed to 31 feet per second, and tolerate unsteady speed, when a wheel is safe at 80 feet, but there are several steam users in the United States w[illegible] regret that they did not draw the line much nearer to former speed.

We have been making progress (so far as speed is co[illegible] t until there is an engine in this vicinity, with a fly-whe[illegible] is in diameter, that revolves 86 times per minute. [illegible] as the rim speed $23 \times 3.1416 \times 86 \div 60 = 103$ feet [illegible] ut in other words the owners (or perhaps the des[illegible] s."

engine have added 29 per cent. to what Haswell declares to be the safe speed for cast-iron fly-wheels.

The reason why this wheel does not burst is found in the fact that Haswell uses a liberal factor of safety, but such practice encroaches too much upon it, especially as the best of cast-iron is uncertain material.

If the governor of such an engine does not operate properly, the speed is increased beyond the breaking point before the engineer can shut the throttle valve, and a serious wreck is the result. Many of these have been illustrated in the mechanical papers during the past five years.

Now this great increase in the speed of wheels is called progress, and a portion of it undoubtedly is; but when rules of safety are so flagrantly disregarded that many lives are lost and thousands of dollars worth of property destroyed each year, are we all ready to admit, after due consideration, that such changes are real progress? When true progress along this line is exceeded, does it not become recklessness? If more recent authorities give the safe speed of fly-wheels at 100 feet per second, does it make the cast-iron stronger than it was before? It is one thing to sit in the designing engineer's office and make the calculations on which the safe speed of fly-wheels is based, but to stand at the throttle, in line with the revolving wheel day after day, is another and very different thing. I am quite sure that if some of the engineers who design, (also some who erect,) our engines, expected to operate the same in every day practice, we should not find so many dangerous features and unhandy combinations in our mills and factories.

I have presented the ideas contained in these lines because many engineers appear to think that every change from previous designs of engines is an improvement, hence denotes progress along these lines, but this is far from true, and even many things that are accepted by hundreds of the craft as superior to those formerly used, are not unqualified improvements, when viewed in a proper light from the right standpoint.

There is too much designing of engines to secure the best theoretical results, without regard to the safety and convenience of those who must spend their lives in operating them, to suit working engineers who give their duties intelligent thought, and their side of the case is not always properly presented in our mechanical papers, some of which are edited by men who are conversant with only the theoretical side of steam engineering. True progress along these lines benefits both steam user and engineer in the truest and best sense of the word, but "all is not gold that glitters," and many changes that are made do not give substantial evidence of real progress.

The Steam Jacket.

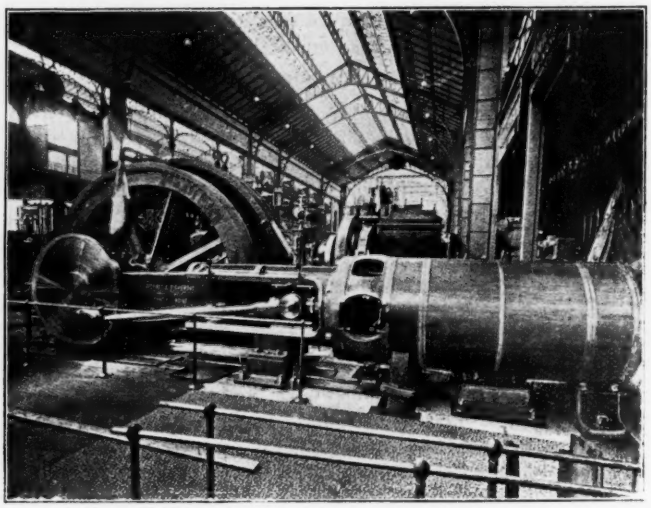
The steam jacket was first used as early as the time of James Watt, who used it, as he expressed it, to keep the cylinder as hot as the steam which enters it. The use of steam jackets is not so extensive in this country as in Europe, where a large number of engines are jacketed. At the Paris Exposition, in 1900, nearly all the engines exhibited from Germany, France and Belgium had steam jackets on both single cylinder engines and compound engines, as representing the latest ideas of engine building in those countries.

The steam jacket consists of an annular space surrounding the cylinder, into which live steam is kept actively circulating, and the heat which is swept out of the exhaust is supplied by this live steam. It is principally intended to make the cylinder condensation less because the entering steam will find the cylinder better when it enters than if the jacket steam was not present, and it also supplies heat to evaporate any of the cylinder steam which may be condensed.

The effectiveness of the steam jacket depends upon the circulation of the live steam from the boiler within it, and no water should ever be allowed to collect in the jacket. It is usually removed by traps or gravity back to the boiler. In some plants, the live steam from the boiler is passed through the cylinder jacket of the main engine on its way to operate some small auxiliary engine and pump. This is a very good plan, as it always secures live steam to the jacket.

The water if allowed to collect within the jacket tends to make the economy of the jacket low, as it has been found in practice that a very small film of water on the inside of the jacket prevents the proper transfer of heat.

Whether it is economical to use a steam jacket on an engine is a matter on which the best engineers are not entirely decided. The reason for this difference of opinion is, that each engine must be tested with a jacket separately, and the efficiency or saving of fuel may be zero in some and as high as 15 per cent. in others. The gain which results from the use of a steam jacket depends upon whether the steam saved in the cylinder is greater than that lost in the jacket. If the engine is very



500 Horse-power Engine with Jacketed Cylinder.

poorly designed the steam jacket will save usually a great amount of steam, but with a well designed engine the gain will not be so great.

The extra cost of the construction of a steam jacket is one of its objections and the saving in fuel must be more than sufficient to pay for the cost of the jacket. This must be settled in each individual engine and each set of conditions. One advantage of the jacket is, that the engine can be started more conveniently, as the cylinder can be warmed up in advance of starting by the steam in the jacket.

The gain from a jacket is less in multiple cylinder engines than in single cylinder engines, because the less the tendency of the steam in the cylinder to condense, the less good the jacket will do, and this is one of the great advantages of the compound engines. In the compound engines, the range of temperature between the admission steam and exhaust steam is divided into as many parts as there are cylinders and the con-

densation is proportioned to the difference in temperature. For instance, in a cylinder of an engine running at a pressure of 100 pounds per square inch, the temperature of the entering steam is about 337 degrees and the temperature of the exhaust is about 220 degrees. The hot steam must, every stroke, strike the comparatively cool walls of the cylinder and naturally some is condensed before the walls of the cylinder are raised to the temperature of the steam. The greater the difference in temperature the greater the condensation. In a triple-expansion engine this range of temperature is divided into three parts, so that the entering steam of the engine does not strike the walls of the cylinder at the exhaust temperature, but at the temperature of the cylinder next to it, the exhaust steam of one cylinder being used as the driving steam in the next one.

Tests which have been made on triple-expansion engines show that the jacket is most effective on the low-pressure cylinder, very little gain being noted when the high cylinder engine was jacketed.

As the steam jacket is used primarily to prevent initial condensation when superheated steam is used, there will be no saving by using a steam jacket, as the temperature of the superheated steam must first be lowered to that of saturated steam before any of it could condense.

One of the chief reasons why the jacketed engine is not used in this country is principally the first cost of the engine, which cannot compete with the unjacketed type. It is also very clumsy looking, as the outside diameter of the jacket makes the cylinder look very large compared to the other dimensions of the engine. Taking everything into consideration, it is found, however, that while jacketed engines do save some steam and run somewhat more satisfactory, the difficulty in construction and, therefore, the increase of cost, make its use in this country limited.

Boiler Explosion Due to Negligence.

The carelessness of engineers in dealing with boilers under their charge is very clearly illustrated by an accident which occured at the Baldwin Locomotive Works, in Philadelphia. In this case the engineer was unfortunately not the only victim of his own carelessness, but two of his comrades were hurt. The boiler belonged to the type of water tube boilers, manufactured by the Heine Safety Boiler Company. In this type of boiler each water leg is composed of a headplate and a tube sheet, flanged all around and riveted and stayed together by hollow stay-bolts. The tubes extend through the tube sheets, into which they are expanded. Opposite the end of each, in the headplates, is placed a hand hole of slightly larger diameter than the tube through which it can be drawn. These hand holes are closed by small cast-iron plates shown in Fig. 1. The bolts holding these plates in place are $\frac{3}{4}$ inches in diameter.

The boiler was running under a pressure of 110 pounds per square inch, and the engineer noticed that there was a leak around one of these hand-hole plates. These plates are held in place by the pressure of the steam and really need no tightening by this bolt when the cap has a gasket on it. However, this engineer thought he could stop the leak by tightening this bolt, and tried his best to do it. In this he was unsuccessful, and, calling two comrades to help him, they forced their combined weight on the wrench. The consequence of this was that the rim around the cap was sheared off and the water and steam rushing out scalded them. This is shown at A, A, Figure 1. A detail of this cap is shown in Fig. 2. The broken line, A, A, represents where the flange was broken off.

The proper thing for the engineer to have done in this case was to have left the leak alone until the pressure in the boiler was relieved and then examine the cause of this leak. A leak in a boiler is not a dangerous thing, and no engineer or fireman should attempt to adjust or attempt to repair it while under

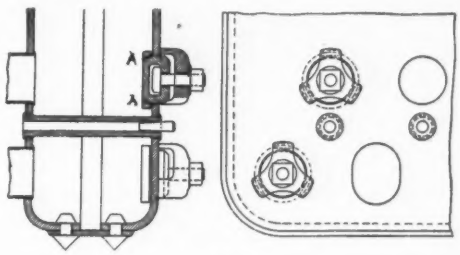


Fig. 1.

pressure. These were the instructions given to this engineer, but he disobeyed them and lost his life by doing what he thought was his duty.

When the boiler had been blown-off as the result of the accident and the pressure removed, it was quickly repaired, and within a few hours the boiler was running again. In comparison with this description it would be interesting to give the account of the accident as described in the newspapers. The account which one paper gave was as follows:—

"Before the accident happened the engineer was working on a part of the boiler where the steam was confined in a small space. He was trying to screw up a nut which was leaking, and his utmost strength was not sufficient to stop it, as by screwing on the nut it only compressed the steam more. He

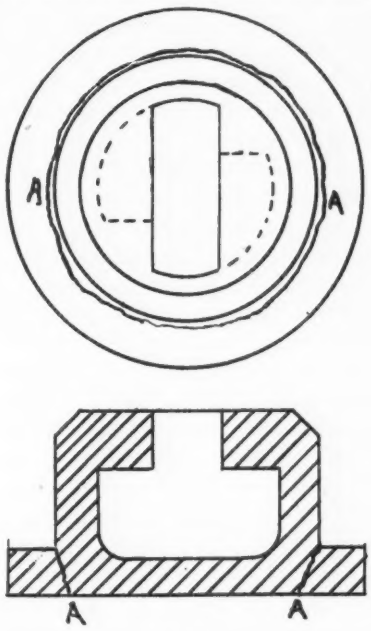


Fig. 2.

then called upon two boilermakers who were standing near to help him tighten the nut. The three men then united their strength in screwing up the nut, and evidently screwed the nut down too tight and so confined the steam in this small space as to raise the pressure to the bursting point. The result was that due to this enormous pressure the boiler burst, blowing out the head of the boiler, killing one man and injuring two others."

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Franklin R. Moore, Chairman **W. S. Wetzler**, Secretary
George W. Richardson
W. J. Eccles **C. W. Leng**

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Steam-Pump Economy. It is doubtful whether there is an operating engineer, who really deserves the title, who is not aware of the gain to be derived from using steam expansively in the cylinder, instead of allowing it to follow the piston at boiler pressure during the entire stroke. The use of multiple-expansion engines, making possible the employment of large ratios of expansion, have shown conclusively the large gain in economy over the engines working with less or no expansion. Even if any engineer felt inclined to doubt the accuracy of these reports, he could readily prove the point to his entire satisfaction by lowering his boiler pressure and lengthening the cut-off of his engine to as late a point in the stroke as possible, and then observing the increased steam consumption as evidenced by the greater efforts necessary on the part of the fireman to maintain a sufficient steam supply.

The ordinary direct-acting steam pump is a common example of a steam engine working without expansion of the working fluid. In it the steam follows the piston at the initial pressure throughout practically the entire stroke. The result is that the steam consumption may run anywhere from 100 to 200 pounds per horse-power per hour.

It is true that the direct-acting pump must work against a practically constant resistance and that it possesses no fly-wheel, so that a practically uniform effort must be exerted, and this accounts for the non-expansive use of steam in these pumps. But there are other considerations which enter into the selection of the pump, and which, more often than not, result in the choosing of the acknowledged wasteful type just mentioned.

There have been successful attempts to operate direct-acting pumps by the use of steam expansively, and some of these have demonstrated their economy in their ability to save steam. But in spite of this, the ordinary direct-acting pump continues to be employed for all varieties of work, regardless of the way in which it consumes the steam.

Perhaps the primary cause is that of first cost. A well-known manufacturer of steam pumps has said that it is almost impossible to sell a high-priced though economical pump when in competition with the wasteful but cheaper direct-acting pump as ordinarily met with, and he speaks from experience. It seems, therefore, that the matter of first cost still has a great deal to do with the selection of machinery and that the question of economy is relegated to second place. Just why such a state of affairs should exist is hard to determine. For it must be evident that a wasteful pump will soon push into the exhaust the heat equivalent of enough coal to more than counterbalance the increased first cost of a better pump.

Of course, the increased economy of the improved pump is obtained by a better distribution of the steam, which in turn necessitates more complex valve gear, and hence added cost in construction. With the addition of a larger number of working parts, also, there comes the greater liability of accidents and troubles in operation, and this in many cases is regarded as disadvantageous. It is true that the tendency should be toward simplicity and few parts, to avoid as far as possible the likelihood of rapid wear and frequent repair. But it ought not wholly to eclipse the matter of economical working.

In many instances simplicity of design and a minimum number of working parts are not only desirable, but necessary. When pumps are to be placed in localities where the amount and quality of the attention they are to receive is very slight, then simplicity and fewness of parts would be essential. But where proper care may be relied upon, it seems as though the pump of higher economy should receive some recognition.

Emergencies. As it is always the unexpected which happens, every engineer should, as far as possible, be prepared for cases of emergency. This is of especial importance in the design of a steam or power plant. The designer should always have in mind that in case of breakdown of an engine or boiler, there should be means at an engineer's disposal which will help him out of the difficulty.

There is probably no plant in this country where such care has been taken in these matters as in the high-pressure fire-pumping station described elsewhere in this issue. Everything in this plant is duplicated and in some cases triplicated, as it is important in case of a large fire that there shall be no breakdown. Each half of the engine room has its own suction pipe and delivery pipe; there are three separate sources of supply of water to the water jackets of the gas-engine cylinders; there are

three separate sources of supply of electric current for giving the electric spark and the same degree of care is exercised all over the plant.

In contrast to this is the breakdown of a heating plant in Indianapolis, where the plant of a company which furnishes heat to several hundred different buildings has just broken down. Scores of families are said to have been forced to seek shelter in hotels, as their reliance on the company had led them to clear their own houses of all heating apparatus.

This incident is interesting in comparison, as it should be possible to devise a heating system which would be beyond the danger of supension from any ordinary cause, or to devise means to prevent the recurring of such a breakdown.

Another Rare Metal

While the properties of Radium are puzzling the scientific and medical world, the metal called Osmium is said to be doing some wonderful things in the lighting world. Like radium, osmium is a very rare metal, and has the highest melting point of any known metal. It is said to melt at a temperature of 4800 degrees Fahrenheit, and for that reason it can be used at a higher temperature than carbon in an incandescent lamp, making the efficiency correspondingly higher. The lamp using osmium filaments is a German invention, and they are not being sold but are rented out. Owing to the low resistance of osmium, lamps of 25, 35 and 50 volts only have been produced, and the smallest candle power of a 35 volt lamp has been 40.

The tests of these lamps show that the average consumption is only about 1.5 watts per candle power. As the voltage increases, the candle-power increases very rapidly, while the watts per candle-power decrease rapidly, but the life of the lamp is very much shortened at these higher voltages. The wonderful illuminating properties of this metal are shown by the following tests of a 20-volt lamp. At 20.5 volts the lamp gave 22 candle-power; at 25 volts the candle-power was 46; at 30 volts the candle power was 99; at 35 volts the candle power was 171; at 40 volts it rose to 275 candle-power and 50 volts it showed 460 candle-power; while the efficiency at this highest candle power was only $\frac{1}{3}$ of a watt per candle power.

The life of filaments made of osmium seem to compare favorably with carbon filaments, as these lamps running under a normal voltage have a life of 1000 hours or over.

While radium is a recently discovered element, osmium was discovered as early as 1803. Like radium, it has some very dangerous properties. It produces a permanent black stain upon the skin and at the same time causes an eruption on the skin which will not heal. Its vapor, which is given off about 212° Fahrenheit, is exceedingly dangerous, both being irritating and irrespirable and it is said to cause partial or total blindness by depositing a film over the eyes. As before stated, osmium is the least fusible of all the metals, and is the heaviest substance known.

While both these metals have very interesting properties, it remains to be seen if these properties will be of practical use to the engineering world.

A Few Things Sometimes Overlooked

Each year the practice of installing boilers of larger horse-power per unit increases. In many cases, however, this practice is not to be advised. Of course the larger the unit the smaller the first cost per horse-power for boiler, brickwork, piping and real estate. While these advantages are of material benefit in one way, it is not well, however, to have your boilers so large that if one becomes deranged, or out of order, that the remainder cannot be forced sufficiently to take care of the regular work. Hence, economy in first cost of installation is not always to be recommended, because if our boilers are of such size that it forces a complete shut down when one is thrown out we stand to lose all, or more than we gained in first cost.

Water-tube boilers of proper design may be forced to, say about 30 to 35 per cent., for a limited time, thus in reckoning the size of units in a battery you may make them of such size that in case of one being cut out the remainder, by being forced, will equal the normal horse-power of the entire battery.

Another feature of latter-day steam plant construction is lack of chimney capacity. There are many users who spend a large amount of money upon their boiler room and then limit its usefulness by a scant chimney. The chimney of to-day is a different article from the chimney of the past. For bituminous coal the minimum height should be 100 feet; for anthracite coal, 125 feet. For plants of over 500 h.p. greater heights are advantageous. Great care should be used in seeing that the boilers have proper grate surface for the kind of coal to be burned. There is lots of room for trouble at this point, hence it should be a point to see that there is ample grate surface to burn either kind of coal in case of emergency. For easy figuring 4 pounds of buckwheat (anthracite) or $3\frac{1}{2}$ pounds of good bituminous coal as the amounts necessary for a boiler horse-power per hour.

The space necessary for boilers of a given horse-power can readily be ascertained by dividing the total horse-power by $2\frac{1}{2}$ or 3, depending on the coal to be used, which will give the number of inches total width of all furnaces, to which must be added 24 inches for each boiler wall. There is, however, a waste space which has to be taken into account for some types of boilers; that is, space for side cleaning. Boilers which require cleaning aisles can be set only in batteries of not more than two each, and require a number of such aisles equal to one more than the number of batteries. As these aisles should be not less than 4 feet, this space must be allowed for. Boilers cleaning from front to rear of course can be set in batteries of any number desired.

The Method of Finding the Amount of Water Used by an Engine per Horse-Power per Hour from the Indicator Card.

The indicator card besides giving the horse-power at which the engine was working, when the card was taken, and the adjustments of valves, also indicates how much water the engine is using per hour. This amount is usually then reduced to the amount of water required by the engine per horse-power per hour, so that it can be compared to other engines, as each engine runs under such varying conditions and is of such a different type. This unit is taken as a standard of comparison.

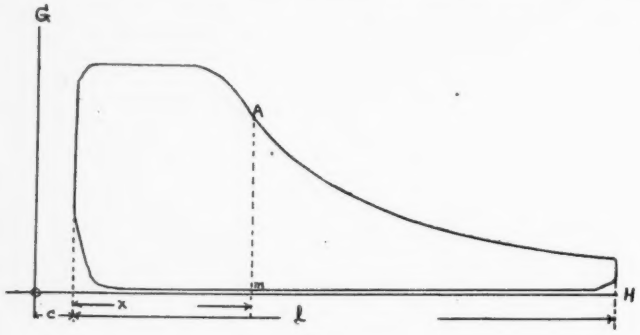


Fig. 1.

The indicator card assumes that all the steam within the cylinder is steam and takes no account of initial condensation or condensation during expansion. It also does not take into account any leakage, either through the valves or past the piston. The only way, that the actual amount of water that an engine uses can be obtained, is by direct measurement. This is either done by condensing the steam after it has passed through the cylinder, and weighing it, or by weighing the water before it enters the boilers on its way to the engine. At the same time indicator cards must be taken, from which the horse-power is obtained, and as the amount of water that the engine uses in one hour can be measured, by dividing that quantity by the horse-power, the real amount of water that the engine uses per horse-power per hour can be obtained. This is usually a very laborious and painstaking process, and the necessary appliances and apparatus are rarely at the disposal of the engineer.

It is for this reason, that the indicator cards are used for this purpose, giving as they do, an indication of the amount of water used by the engine and therefore the economy. An engine always uses more water than that represented by the indicator diagram, but never uses less water than that shown by the diagram, so that if the diagram should show an uneconomical consumption, the engine is sure to be uneconomical, but if the indicator card shows that it is economical, it may or may not be true. This latter depends upon whether there is much initial condensation or much leakage. The more leakage and initial condensation, the more will the theoretical amount differ from the actual amount. There is always some of this present in every engine and it is for this reason that an indicator card represents the least amount of water that the engine can use.

The method for finding this amount is explained as follows:—

Fig. 1 represents an indicator card taken from an engine. The following data must be known about the engine and card. The dimensions of the engine must be known, that is, the length of stroke and diameter of cylinder, and speed of the engine. The clearance space of the engine should also be known. If it cannot be obtained from the drawing of the engine or by actual measurement, it must be assumed from some engine of the same type, whose clearance is known. By clearance in this case is not meant the mechanical clearance between the head of the cylinder and the piston, when the piston is at the end of the stroke, but the volume of steam that is required to fill the valve passages plus this mechanical clearance.

The data that should be known about the card is its length, the scale of the indicator spring with which it was drawn and the horse-power, which can be obtained from the area of the card by the usual formula.

$$\text{Horse-Power} = \frac{PLAN}{33000}$$

Where P = mean-effective pressure in square inches.
A = Area of cylinder in square inches.
L = Length of Stroke in feet.
N = Number of Strokes per minute.

The mean-effective pressure is obtained by multiplying the area of the card by the scale of the spring and dividing the product by the length of the card,

$$\text{or, } P = \frac{\text{Area of the card}}{\text{length of the card}} \times \text{scale of the spring.}$$

The most accurate method of procedure is to assume some point on the expansion line of the card as at A, and find the pressure that corresponds to it. The line A m represents the position of the piston at the point A. As no more steam can enter the cylinder from the boiler after cut-off, any point can be taken on the expansion curve after cut-off. The percentage clearance being known, the line O G is erected at a distance

Steam Table.

Absolute Pressures	Tempera-tures	A	B	A + B	Volume of one Pound	Weight of one Cubic Foot
		Sensible Heat, or Heat of the Liquid.	Latent Heat, or Heat of Vaporiza-tion.	Total Heat from Water at 32°		
Lbs.sq.in.	Fahr.	Units of Heat per lb.	Units of Heat per lb.	Units of Heat per lb.	Cubic Feet.	Pounds.
1	102.	70.	1043.	1113.1	334.6	.003
2	126.3	94.4	1026.1	1120.5	173.6	.0058
5	162.3	130.7	1000.8	1131.5	73.22	.0137
10	193.3	161.9	979.	1140.9	38.16	.0262
14.7*	212.	180.8	965.8	1146.6	26.64	.0376
20	228.	196.9	954.6	1151.5	19.91	.0502
25	240.	209.1	946.	1155.1	16.13	.0620
30	250.3	219.4	938.9	1158.3	13.50	.0736
35	259.2	228.4	932.6	1161.	11.75	.0851
40	267.1	236.4	927.	1163.4	10.37	.0964
45	274.3	243.6	922.	1165 6	9.287	.1077
50	280.9	250.2	917.4	1167.6	8.414	.1188
55	286.9	256.3	913.1	1169.4	7.696	.1299
60	292.5	261.9	909.3	1171.2	7.096	.1409
65	297.8	267.2	905.5	1172.7	6.583	.1519
70	302.7	272.2	902.1	1174.3	6.144	.1628
75	307.4	276.9	898.8	1175.7	5.762	.1736
80	311.8	281.4	895.6	1177.	5.423	.1843
85	316.	285.8	892.5	1178.3	5.125	.1951
90	320.	290.	889.6	1179.6	4.858	.2058
95	323.9	294.	886.7	1180.7	4.619	.2165
100	327.6	297.9	884.	1181.9	4 403	.2271
105	331.	301.6	881.3	1182.9	4.206	.2378
110	334.6	305.2	878.8	1184.	4 026	.2484
115	337.9	308.7	876.3	1185.	3.862	.2589
120	341.1	312.	874.	1186.	3.711	.2695
125	344.1	315.2	871.7	1186.9	3.572	.2800
150	358.3	330.	861.2	1191.2	3.011	.3321
175	370.7	343.	852.	1195.	2.603	.3841
200	381.7	354.6	843.8	1198 4	2 294	.4359
225	391.8	365.1	836.3	1201.4	2.051	.4876
250	401.	374.7	829.5	1204.2	1.854	.5393

* Atmospheric pressure.

from the admission line equal to that percentage of the length of the card. That is, if the clearance is 5%, the distance c, is 5% of the distance l. Next find the pressure of the steam at point A. This is obtained by measuring the height A m and multiplying it by the scale of the spring. To this pressure is added the pressure of the atmosphere 14.7 pounds, as the steam tables, which must be used, always record pressures that way. When the pressure is found, look in the steam table for the weight of one cubic foot of steam at that pressure. At that pressure, there is a certain number of cubic feet of steam in the cylinder, which is equal to the volume of the clearance plus the volume of the cylinder up to the portion of the stroke represented by the line A m. If this number of cubic feet is multiplied by the weight of a cubic foot of steam at that pressure, it will give the number of pounds of steam required per stroke. This quantity multiplied by the number of strokes per minute will give the number of pounds required per minute and when multiplied by sixty will give the number of pounds of water required per hour. If this is divided by the horse-power it will give the number of pounds of water required per hour, if there was no compression on the indicator card. Putting this in another form,

if W = Water required per hour.
c = Clearance in cubic feet.
x = Volume of cylinder up to point A.
s = weight of steam per cubic foot at pressure at A.
n = Number of strokes per minute.

then $W = (c + x)\, s \times n \times 60$.

gives the water required per hour, and the water per horse-power per hour is found by dividing W by the horse-power of the card, or

H P = Horse-power of card
and W = Water per hour required, then the water per horse-power per hour equals

$$\frac{W}{H.P.}$$

For example, take Figure 2. This indicator card was taken off a Corliss engine having no compression and suits our case. This engine is directly connected to two single-acting ammonia compressors. The data of the engine is as follows:—

Diameter of cylinder ...	= 20″
Length of stroke	= 21″
Revolutions per minute ...	= 55
Horse-power, calculated ...	= 57.4

On the indicator card, the point A has been selected. The height A m is equal to one inch and the pressure at A corresponds to 60 pounds per square inch or 75 pounds absolute. The clearance for this type of engine is about 5 per cent. The weight of a cubic foot of steam at 75 pounds pressure, by looking in the steam table, is found to be .1736 pounds. The length of the card is 2.72 inches. The distance $m\,x$ is found by measurement to be 0.4 inches.

Substituting the proper values in the formula, remembering that the volume of the cylinder must be found and the number of strokes is twice the number of revolutions.

$$W = (.05 + \tfrac{0.4}{2.72}) \left(\tfrac{\text{Volume of cylinder}}{\text{in cubic feet}}\right) (.1736 \times 110 \times 60)$$

$$W = (.05 + \tfrac{0.4}{2.72}) \left(\tfrac{3.1416 \times 100 \times 21}{1728}\right) (.1736 \times 110 \times 60)$$

from which it is found that

$$W = 874.3 \text{ pounds of water per hour.}$$

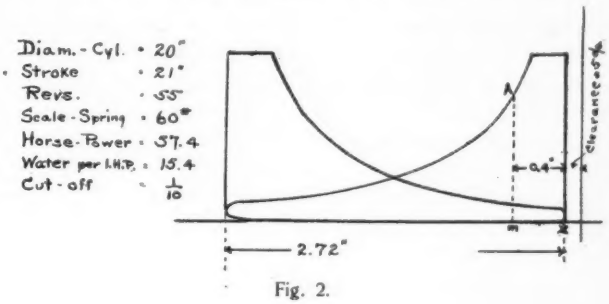


Fig. 2.

As the horse-power is 57.4, dividing W by this quantity, it is found that water per horse-power per hour

$$= \tfrac{874.3}{57.4} = 15.4$$

pounds.

When an engine has compression there is some steam saved every stroke and this quantity must be found and deducted. Fig. 3 represents a card taken from a high-speed engine. The data of this engine is as follows:—

Diameter of cylinder	= 10″
Length of stroke	= 10″
Revolutions per minute	= 303
Horse-power, calculated	= 50.31

On the indicator card the height A m is 0.75 of an inch, which corresponds to a pressure of $0.75 = 80 \times 60$ pounds per square inch or 75 pounds absolute. The weight of steam at

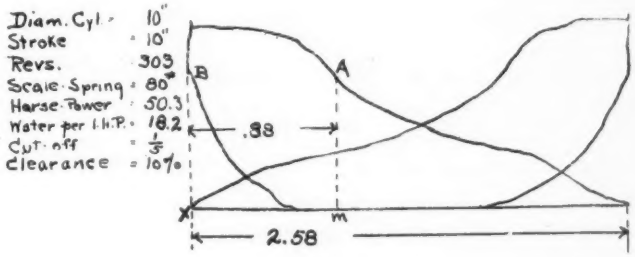


Fig. 3.

that pressure is .1736 of a pound per cubic foot. The clearance of this type of engine varies from 8% to 12%. We will assume the clearance to be about 10%. Using the same formula as before,

$$W = (0.1 + \tfrac{.88}{2.72}) \left(\tfrac{3.1416 \cdot 25 \cdot 10}{1728}\right) (.1736 \times 606 \times 60)$$

W = 1216 pounds, neglecting compression.

To calculate the amount saved by compression, the easiest method is to take some point as B, Fig. 3, which is on the compression curve just before admission. It is then known that the clearance space is filled with steam at that pressure before admission, and therefore, saves that much steam every stroke. The volume of the clearance is known, in this case 10%, and

the height B$\times$ is 0.8 inches, which corresponds to a pressure of $0.8 \times 80 = 64$ pounds per square inch or 79 pounds absolute. In the table this will correspond to a weight of .1820 pounds per cubic foot as it is less than 80 pounds, the nearest reading in the table. The amount saved then is the cubic contents of the clearance, multiplied by the weight of steam at the pressure considered. This gives the weight per stroke and multiplied by the strokes per hour gives the weight per hour, or if $w =$ weight saved, then

$$w = \frac{1}{10} \times \frac{3.1416 \cdot 25 \cdot 10}{1728} \times .1820 \times 606 \times 60$$

or $w = 300.8$ pounds per hour saved by compression.

The amount of water used as shown by the indicator card is then $W - w = 1216 - 300 = 916$ pounds and the water required per horse-power per hour is then

$$\frac{916}{50.31} = 18.2 \text{ pounds.}$$

The above method is a logical one and every step in the process can be easily understood. It is also the exact method. These calculations can be very much shortened by cancelling many of the same qualities that occur both in the numerator and the denominator of the fraction $\frac{W}{H.P.}$ but it gives a formula which can only be explained by the preceding calculations, and hence, if not understood, is very confusing, and therefore it will not be given. With any given engine, however, this method is very short, as there are a number of constants and few variables. For instance, the volume of the cylinder is constant, the clearance is constant, the number of revolutions is nearly constant and for most calculations can be assumed nearly so, as there is almost as much possibility in making an error in reading the exact number of revolutions as there is of the engine changing its speed under the usual running condition. As the horse-power of the card is known, the only extra measurements that must be taken are the position of the point A on the card with reference to the admission line and atmospheric line, and also the pressure at the point B if the engine has compression.

Noon Hour at Powers' Mill.

PART VII.

By A. Edward Rhodes.

Say, boys, Mr. P. wants me to use barley sprouts for the purpose of preventing scale in that new boiler over in the machine shop. You know that the water supply over there is very hard lime water, and I don't know anything about them. What virtue is there in barley sprouts anyhow? Well, Dick, I don't know much about it, only what I have read, and that is that the value of vegetable matter as scale preventatives in steam boilers depends upon the acids which they contain, or in the case of potatoes or starchy compounds, they seem to act mechanically by enveloping the solid particles and preventing their adhesion to the boiler plates. Gall-nuts, logwood, hemlock, mahogany, etc., act through the tannic acid they contain. Molasses and vinegar, and many other articles sometimes used, owe their action to acetic acid, which is dangerous if present to excess. Barley sprouts probably contain more or less acetic acid, but doubtless owe the greater part of their action to the starch which they contain.

Jist hear the kid, he talks like a perfesser, but give him his dues, for he said he got it outen a book. For my part, I don't believe barley sprouts is any good. I never heard tell on anyone usin' of them anyhow, and I don't believe in puttin' stuff into my boilers what never has been put into some other biler and tested. I don't know where Mr. P. got the idear from, but it's no good, and I won't put any in, less he says I must.

Sure, an' I would like to know why the boss don't send a bottle to some of these fellers what advertise to analize (whatever that is) your biler water free, an' tell ye phat mikrobes is in it, an' how to git them out. Leastwise, it don't cost nothin'. Yis, I was readin' a 'hole page advertisement yisterday, a-sayin' as how these mikerobes git inter the biler and as how the bilin water killes them off, and then, bein' heaver than bilin water, they sinks to the bottom of the biler, and cool off and get hard when the fire is banked at night. This article wint on to say that mikerobes and bactoberia shortened the life of many a biler. Now phats the matter wid ye all, sure an' it's a fact, I borried the paper from Hans, an' it said so in black and white.

Oh, Dennis, Dennis, you will be the death of us all yet, you got a health article on pure drinking water mixed up with a boiler compound advertisement. However, you are right. The only correct way is to have an expert chemist analize a sufficient quantity of your boiler feed water and then have him give you a formula by means of which you can have a dissolvent made that will keep the boiler in a first-class condition. Oh say, kid, don't talk all dinner time but give the rest of us a chanst to talk. As I started to say, when you came at us with what you read outen a book, I was agoin' to say that I recommended to Mr. P. that he sends a gallon of that water to the "Scalem Boiler Cleanin' Co.," to be run through their machine fur a test, fur says I, it won't cost nothin' but the express, an' I believe he is favorable. Leastways, he says, says he, Dick, wash a bucket good an' clean an' bring it to the office, an' be sure there is no foren matter in it, but that it is jist the same as in the well.

I vos vondering if der scale vos in der vater like liddle bardicles of sand, or if it vos somedings vot got hard by der biling of der vater. If it vos like some sand, I dinks it must go at once mit der boddem down, und den if dot vos der case, all dis droubles abodt scale prewentation combounds can be safed by a seddling tank through vitch der vater can be drawed like a sif. I gess ve must haf some more book learnin', aint it, kid?

Well, Hans, I don't know, it seems to me that you fellows are rubbing it in pretty hard, still, if it is any satisfaction to you, why go ahead, but remember that this same book learning represents hours of hard study at times when some of you were having what you are pleased to call having a good time. Still, I believe, that the time will come, and I think most of you agree with me, even if you do pretend otherwise, when I will receive ample return for every minute spent in study. Now, to get back to your question. As I understand it, in our case the scale is formed by minute particles of lime, and you want to know if the lime floats on top of the water, or if it sinks immediately.

Yah, dot vos der quvestion put as never I could do him.

Well then, Hans, I was reading up on this very thing only a few days ago, right after we found how rapidly scale was forming in the boilers, that get their water supply from the

quarry well, and I learned that carbonate of lime is held mechanically in suspension for a time and then settles to the bottom of the boiler. Sulphate of lime, or what we know better as plaster-of-Paris, is twice as heavy as water, and at once sinks. Carbonate of lime, when treated in the boiler or heater with tanic acid, becomes decomposed into tannate of lime. It is lighter than water, and therefore comes to the surface of the water and then may be removed by the surface blow-off.

I also read that water, as it occurs in and on the earth, is probably never absolutely pure, but contains solutions of different substances, according to the kinds of soil or rock with which it has come in contact. Rain is the source of the land water, it having been taken up by evaporation from the ocean, lakes, and rivers to be returned again. As it falls a part flows off, as surface water, in brooks and rivers, a part sinks into the earth, slowly percolates through the earth and rocks, and finally comes to the surface in springs and driven wells. Much water is absorbed from soil by the roots of plants, and exhaled through their leaves into the atmosphere.

The two sorts of water from rivers and springs differ considerably in the character of their impurities. River water contains organic matter, spring water generally holds salts in solution. Organic matter tinges water yellow, as can best be seen by a waterfall. This organic material is either dead or living. Micro-organisms so minute that millions may exist in a cubic inch and be entirely invisible, are contained in all stagnant ponds and in much river water. Some of them are harmless, others are germs of infectious disease.

The salts in spring water are derived from the rocks and earth through which it has found its way. Some contain compounds of iron in solution, some sulphur, and water in limestone regions is hard and limy. Hard water contains either lime or magnesium salts in solution, usually the former. It is called hard by reason of its action on soap, which instead of dissolving in water, forming a lather, and cleansing the skin, combines with the salts to form an insoluble lime or magnesium soap, that appears as a precipitate, or a scum on the surface of the water.

Boiling precipitates the carbonates of calcium or magnesium, which often appear as a crust on boilers and kettles. This crust, in steam engineering, is commonly called scale. Water constitutes about 60% of the human body, it being found in all the tissues. Every article of food contains some water. Plant life also contains a large proportion of water.

Water exists in three states—solid, liquid, and vaporous. It freezes at 32°, suddenly expanding considerably as it passes into the solid state, and boils at 212° under atmospheric pressure. If the pressure is greater, the boiling point is raised; that is, it takes a higher temperature to overcome a greater pressure. Diminished pressure lowers the boiling point. Salts dissolved in water raise its boiling point and lower the freezing point to an extent depending on the kind and quantity of salt.

Water evaporates at all temperatures, even from ice.

Pure water has hardly any taste or smell, and in small quantities no perceptible color. Water falling after a long rain is nearly pure. All sorts of water may be purified by distillation. Distilled water has a flat taste. For drinking purposes it may be aerated by passing purified air through it.

Some Steam and Gas Engines at the St. Louis Exposition.

As the St. Louis or Louisiana Purchase Exposition approaches its opening date the buildings and exhibits are also approaching a more nearly state of completion, and the managers hope that by April 30th, 1904, the opening date, everything will be in readiness for the public to inspect.

The two buildings which will interest the engineers most, are the Machinery building and the Electrical building. Machinery Hall is an L shaped building, 1000 feet long and 500 and 350 feet wide. It is estimated that engines aggregating 60,000 horse-power will be installed in this building on the main floor; the engines, condensers, pumps and accessories will be located in the western half of the building, while machine tools, wood-working machinery, fire engines, etc., will occupy the eastern half.

The Steam, Gas and Fuel Building will be located west of the Machinery building and will be used for generating the steam and gas necessary to supply the power for the engines in Machinery Hall. The building is now in the course of erection and when completed will contain all types of boilers from foreign as well as domestic makes, as well as economizers, feed-water heaters, damper regulators, water regulators, etc. The pumping exhibit will be a large one, all the water which falls over the artificial cascade, as explained in previous issue, will be pumped by three 36-inch single stage, turbine centrifugal pumps, each having a capacity of 30,000 gallons of water per minute. The total horse-power of these pumps will be 6000, making it one of the largest electric pumping stations in the world.

Machinery Hall will contain many large steam engines. of different types, gas engines and turbines, and water wheels. Some of the American Machines can be mentioned as follows: There will be a 5000 horse-power unit shown by the Allis–Chambers Company, and direct connected to the generator; a 600 horse-power steam engine from the Harrisburg Foundry and Machinery Company, a 750 horse-power steam engine from the Tone and Bodley Company of Cincinnati; and a 900 horse-power engine from the Murray Iron Works, of Burlington, Iowa.

Europe will be represented by a 2500 horse-power vertical cross compound engine; a 1000 horse-power tandem compound engine, and a 1500 vertical triple-expansion engine. The gas engines from Europe will consist of a 3000 horse-power gas engine directly connected to a General Electric alternator; a 1500 horse-power French engine directly connected to a generator running 330 revolutions per minute.

The steam turbines will be represented by 8000 horse-power turbine from the General Electric Co., and a 5000 horse-power unit from the Westinghouse Company, as well as many smaller ones from this country and Europe.

Numerous types of water wheels will be exhibited, among them being an impulse water wheel operated under 300 pounds pressure and running at a speed of 900 revolutions per minute. The feature of the exhibits will be that every engine will be directly connected to its generator, and no line shafted will be erected in any of the buildings.

Within the Electrical building there will be shown all the different types of motors, switchboards, controllers and auxilliary devices, as well as hundreds of other electrical instruments and appliances of all classes.

LETTERS FROM ENGINEERS

IN ORDER to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories, and general engine-room experiences are especially solicited.

Peculiarities of Oils

Editor PRACTICAL ENGINEER:

The testing of oils is an interesting study, as it usually presents so many unexpected surprises. The writer has had a few years of experience with an oil testing machine and while trying to find some law between co-efficient of friction, temperature and pressure has noticed many peculiar results.

There is, apparently, a certain volatile property which evaporates under heat, but the period in which such evaporation takes place is very various in different oils. It might be thought that after such evaporation the residue would be in the nature of an essence, and give different physical tests of better quality. But this does not appear to be the case, such residues giving a lower flash point than the original oils before the distillation of the volatile constituent. Nor is the percentage of loss by such distillation inversely to the commercial price of the oils. In fact, it appears to be rather otherwise. Amongst a series of high-priced and cheap oils, one of the cheapest seemed to be the most stable and least affected by a high temperature under a considerable lapse of time. No one oil seems to excel under all tests. Thus it is very difficult to say of any oil that it is a perfect lubricant, or even the best lubricant for all purposes. The best oil for a cylinder under moderate steam pressure may be one of the worst for higher pressure or for dry explosion engines. In some cases oil will lose nearly 50 per cent. of its volume under a temperature of nearly 400° F. in a very short time, and then seems to be stable for any future length of time. Again, an oil may be the finest type of cylinder oil it is possible to make, yet prove quite unsuitable for a certain kind of valve or engine, because it does not contain a peculiar quality or property which has been found in practice necessary for good lubrication of that particular valve or engines. All this would appear to point to the fact that for the present the selection of the best oil for a particular purpose must be ascertained rather by direct experiment under the particular conditions of work, rather than by reliance upon any so-called standard tests which may only indicate the best oil under the particular circumstances of such test.

Philadelphia, Pa. O. C. S.

What Made The Brasses Heat.

Editor PRACTICAL ENGINEER:

Well, what do you want done to-day, Boss? I finished that cross-head key for Brelly's Mill last night; my time on that job is 27½ hours, including the over-time. All right, Joe, go over to Pannell's sash factory and see what is the matter with that Corliss engine. Mr. Kelly was here last evening and he told me that he couldn't afford to give the work to Mettle Machine Co., because they had had four different men at the mill in one week to repair the engine and the repair bill was over $150, and still the engine was as bad as ever. You go over and look at the crank-pin brasses, the engineer there says that they keep running hot every day and he can't keep 'em cool even with water on 'em, when a heavy load is on the engine. After gathering up what tools I thought necessary to fit a pair of pin brasses with I was soon on the suburban trolley line and soon at the scene of the trouble.

On entering the engine room the first person I met proved to be Mr. Kelly, the general manager. He introduced me to the engineer, who straightaway began to pour out his troubles. Look here, this pin runs hot most every day and I cannot find what makes it, I have tried everything I can think of. I tried the brasses for side play on both stroke ends, on each quarter and on each eighth; there was no binding—I can shake them freely by hand, as you see. I took them off and had ample clearance space cut on both brasses, and made sure of the bearing being right. The oil creases are cut in amply deep, as you can see, and that they distribute the oil well. In fact, I have done everything I can think of that would prevent the heating. There is no knocking or pounding in the engine whatever, this fact makes me wonder at what the cause really can be. Now, then, I have told you all I can, so you try and see what I have left out. I then spoke up to the engineer and asked him if he had a small steel bar about two feet long. The nearest we got to it was a ¾″ bolt, 26″ long. I placed one end of the bolt as a pry between the back of the crank disc and the pillow block, and gave it a sudden jerk, the result being that the shaft moved on end almost ¼″, and here was the cause of the trouble. I examined the crank shaft and bearings, tried the level on the shaft and it was all right. I next looked over the fly-wheel, which was all right, then I carefully examined the band wheel, and here was the seat of the whole matter. This band wheel was housed in so as to prevent any accident to the help, and of course being covered up the pulley was naturally overlooked. The pulley on the line shaft on upper floor was not in line with the large pulley on the crank shaft; this made the belt run on the side of the crown of the driving pulley, which in turn had a tendency to force the shaft on end toward the crank-pin end, there being no collar or shoulder on the shaft next the pillow block. The end play the shaft had naturally made the pin run hot. It took but a short time to line the driven pulley to the driving pulley and a loose collar and a tight collar were placed on the shaft, next to the pillow block, to prevent this end play of the shaft should the pulleys become out of line. This being done, the engine started up and it ran all right that day. I guess it is all right yet, I never heard from it since, and the Boss says they paid the bill without a murmur.

(BURLAP.)

Broken Cylinder Head Repair.

Editor THE PRACTICAL ENGINEER:

I think Mr. X. N. Trick's reasoning (on page 20, November number of THE PRACTICAL ENGINEER) is good, providing the load be light, but if the engine is laboring under a heavy load, I would advise another plan, which would cause about one hour shut down.

Remove the cylinder head and have a band shrunk on it,

then replace and there will be no leak, if the blacksmith does a good job.

I have had two cases of this kind and one was an air compressor, and it was very necessary to keep the compressor going.

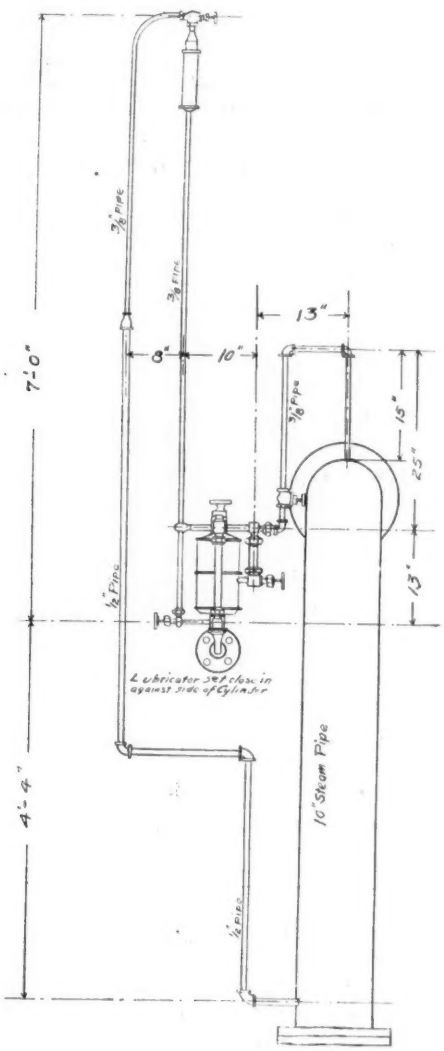
The blacksmith shop being near by, it took less than an hour to do the job, and so well did it hold that it was several months after the new head arrived that the new one was used, and then not because it was not holding, but because it did not look quite so neat.

J. G. BROWN.

Sight Feed Lubricator.

Editor PRACTICAL ENGINEER:

The accompanying sketch shows a lubricator and the way it was connected. Why will it not work? Kindly answer in your next paper. I would be pleased to hear from readers of the PRACTICAL ENGINEER.



A Lubricator that will not work.

St. Louis, Mo. A. S.

Rodney's Troubles

OR DO WE NEED A LICENSE LAW IN MICHIGAN.

(Third Letter.)

mistur editur mebby u dont think ule get ure munny fur showen me how tu fix the watter hammer in my injine but ure rong, fur ef u luk in this lettar, ul get a ekspres ordur fur the hul ov it. i did not cend it befour as u no the fall is comin on now and i neaded fiv nu steal traps fur to ketch mincks and skunks and weesels and wel u no whut kind ov gaim is around munrow kounty. now speekin ov steal traps, henry was reedin tu me about a nu kind of steem trap, tel me du thay hav to ketch the steem in a trap whear you liv. if u hav a piktur ov 1 handy kud u cend it tu me fur i wud lik tu se 1 wonst. jist 1 mor thing i wud lik to ask u about, henry wus reedin about sum injine haven tu mutch kooshen, i kant ce whut he meens fur mi ingine has no sich a thing as kooshen, fur i run it, and i tel u it jist keaps me a goin al thu tim firin up and puttin watter in the barel fur to put in the biler thru the pump. u no it is the thing u told me how to fix, mistur editur if u kud tel me whear i could git a injine with a gud big kooshen on it id swap off mine fur it and giv sumthin to boot.

if u ken let me no about it rite at wonst. 1 more wurd, the thing up on top uv the biler whut hes a long bar on it that hes got nitches in it evry so fur, and a big boll on the end uv it, whi, thet thing leeks. rite hear i wud lik tu no what it tiz, henry sez it iz a saflitty valv, gorg washmun sez it is a releef valv and tom, mi kuzen, sez it is iz a blo oaf valv, now which iz it ? it kant bee the hul 3. anihow, it wus leekin thu uther day and i put a peece ov roap rite on the end ov the bar and tide the uther end tu 1 ov the wheals ov the biler, and jist stopt the leekin rite thear. wel in a litel while, a fellar, sum stranger cum up and he lukt at the gaig, i meen steem gaig, and it shode mourn 195 wel he jist cut that roap and run as fast as his legs kud taik him yellin at the top of hiz voise, yule blo her up, yule blo her up. wel now, mister editer, he wuz a smart alek, fur she did'nt blo up attal, the gaig jist changed bak tu 80 and evry thing iz al rite but a littel cisseln in whear the fire iz. mi bruthur henry told me not tu put the roap on any moar, and to ask u to tel me whi not. if ule hury a bit and anser rite away ile be mutch obligged.

rodney gumkirk,
arkners corners
munrow kounty Mishegan.
in kair ov mi father.

The Condenser Problem.

Editor THE PRACTICAL ENGINEER:

In the November number of THE PRACTICAL ENGINEER, I notice an inquiry by Mr. Switzer in regard to the probability of his condenser working in a satisfactory manner.

As I have never seen any such apparatus I cannot say positively, but looking at it "from the road" it seems a little doubtful.

If I understand the problem rightly, the water must be lifted 18 feet in starting. This would require more than 16 inches of vacuum, which I should hardly think could be produced without an air pump.

The use of a pump for forcing the condensing water over would involve the problems of the injector condenser. If water was being pumped into the condenser, the vacuum breaker would not regulate the water level, and I should think that there would be danger of the water backing up to the engine under some circumstances.

In the hope of being set right, if I am wrong, I cannot see that W. A. D.'s arrangement is any safer than the other. In all jet condensers that I am familiar with, the water enters at a higher point than does the steam usually through a spray plate.

But there should be one or more valves between the water supply and the engine, and it should be closed when stopping the engine.

Mr. Switzer has a valve in his exhaust pipe, and I assume a relief valve to the atmosphere, between that and the engine. If this exhaust valve is closed when stopping, I do not see how he is likely to get any water in his cylinder. But if for any cause the water should back up, the difference in height would make very little difference.

Providence, R. I. L. W. C.

Humming in Boilers

Editor PRACTICAL ENGINEER:

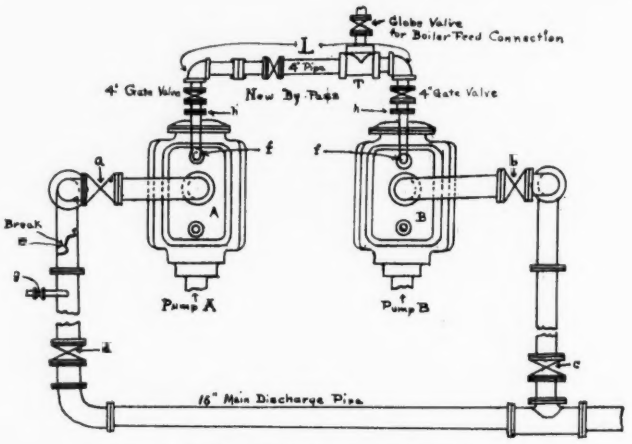
It is evident from the decription of a humming noise in his boiler, that J. W. Angus gives in your November issue, that it is caused by a bad steam leak. It is often a very difficult matter to locate exactly where the leak is. About twelve years ago, I took charge of a steam plant which consisted of six return tubular boilers, three engines, two boiler feed pumps, two injectors and a fire pump. I was informed by the fireman that when the pressure exceeded 100 pounds on number three boiler, it would begin to hum and sometimes roar. It was quite an undertaking for a new man to start in and locate this noise, but I made up my mind it must be done, as that was what the company paid me for. So I had the fireman get her humming in a good loud tune and began to strip the coursing on top of the boiler and with a small tallow candle, I held the flame close to the seams and rivets. I went all over the boiler until the back end was reached and I had about given up the search, when my candle went out. Upon examination, I found a small hole had formed between one of the rivets and the shell. This hole was so small that it could not be seen with the naked eye. The rivet was cut out and a new one put in and the humming bid us good-bye.

Cambridge, Mass. W. A. D.

Emergency Repairs.

Editor PRACTICAL ENGINEER:

I was sent out from the shop to a small water works in Western Pennsylvania to repair or rather put in a new piece of 16 inch cast-iron pipe, this pipe being a part of the discharge line from one of the pumps. The pumps were cross compound (fly-wheel) type, capacity about 4,000,000 gallons per day. Water was pumped at a pressure of 100 pounds direct into the mains, one pump being in service while the other is undergoing any repairs; in fact, each pump was operated two weeks at a time. Well, it is always when least expected that the worst happens. While I was putting the length of pipe in at (*e*) in the sketch and everything was running along nicely, suddenly pump (*B*) started to race, and act as though something was wrong in the water cylinder at (*B*). The pump began to jerk and act as any pump will when a suction valve lets go, or the plunger packing blows out. We certainly were in a bad fix with the discharge line torn apart on one pump and a suction valve gone in a water cylinder in the other, but fortunately there is a way out of everything, and this case being no exception, we got out of it in the following way:



A Broken Pipe Emergency Repair.

By connecting the discharge sides of the two pumps together as in sketch, I pulled through very nicely. The water cylinders *A* and *B* represent one cylinder of each pump. The hand holes at (*f*) were connected together by the by-pass (*L*) at (*h*), thus enabling us to operate pump (*A*) through by-pass (*L*) to discharge chamber of pump (*B*), thence through main discharge line from pump (*B*). The 16″ gate at (*a*) being closed, also the 16″ gate at (*d*) closed, prevented us from getting our boiler feed water, for the supply was taken at (*g*). So by putting the T in the 4″ by-pass it enabled us to get an ample supply of water for all purposes. The two hand hole plates at *f* and f were each fitted with a nipple and 4″ gate previous to this accident, they having been put in for fire purposes about the premises, so it took a very short time to cut two 4″ threads in a power-die that we had in the building. This simple connection saved the company many dollars and much annoyance. ARK. WES.

Where is the Man-hole?

What They Found When They Found It.

Editor THE PRACTICAL ENGINEER:

A short time ago I was sent out to do some repairs to some mangling machines in a large, well-equipped laundry. While I was doing my work, I had occasion to go into the engine and boiler rooms, where some of the machines were I had to repair. Naturally, I was interested in the engine room, for I had been in the engine room for a number of years, and perhaps might have been at the time in mention; but I had not been a resident of the city long enough, so I had to work at the machinist trade until the requisite 6 months had passed before I could get the city license for stationary engineers.

I noticed on entering the fire room that the boiler was blown

off, and that a well-dressed man was questioning the engineer about things in general pertaining to the plant. One question the man (who proved to be the inspector for a Casuality Co.,) asked was, Where is the man-hole on this boiler? and the answer from the engineer was, I don't think the boiler has a man-hole. I never seen one, and I've been here five months and I've washed out the boiler five times in that time. Well, says the Inspector, the boiler must have a man-hole. Where is the dome located? The engineer pointed to a small space over the top of the boiler, which formed part of the second floor of the building, and the part above the boiler proved to be the office where some twelve or fourteen people were employed. Directly under the chair of the manager of the laundry was a thick piece of asbestos paper. After lifting this up, there was a regular trap-door, and under this there was an 11″ x 15″ man-hole. On finding this, the inspector stormed furiously. I don't know just what he said, but he had them jumping around waiting on him. Pretty soon one fellow brought him a pail and I saw this fireman take out 9 pails full of mud or sediment from the steam dome. Well, after the inspector was through, I heard him say that there was 8½″ of mud in the dome. That was not all, for he took three of the dome braces out of the dome with his hands just the same as if they were pipe stems. 'Twas only a short time until two boiler makers were on the grounds ready to repair any defects in the boiler. Later 'twas found that all the longitudinal braces were loose, and one of the diagonal braces on the front head was loose. The blow-off cock lead from the back head of the boiler and there was a great deal of mud around the flues at both back and front of the boiler. Now this boiler had been regularly *inspected* (?) by a city inspector, internally every 12 months and externally every 6 months. I think this so-called city inspector, for the public safety, should be *inspected* a bit. For as sure as fate, if that boiler would have run much longer without cleaning, it would have made big head lines for the local newspapers.

SOREHEAD.

Effect of Cold Air on Boiler Tubes.

Editor THE PRACTICAL ENGINEER:

Several years ago a boiler of the locomotive type was installed in an electric-light station. In a short time the flues began to leak. Five different boilermakers tried to fix the leak, but after a short time they always leaked again.

I happened to be called to examine another boiler that was in very poor repair, and I found that it would require a boilermaker. I sent to the same shop for them that repaired the leaky boiler in the electric-light station. This man was considered to be the best boilermaker in the establishment and discussed with me the cause of the leaking boiler in the electric light station. I explained it this way.

In the first place the firing doors are kept open too long, and there is a very strong draft when the doors are open. The cold air rushes in over the fire and contracts the flue sheet, which causes it to bulge and the flues to leak. There were no doors at the ash-pit, therefore the fireman cannot check the draft except by opening the doors, as there is no damper. He took my advice and went back to the electric plant, had the flues expanded and doors put on the ash-pits, and gave his instructions to the fireman. The boiler was run for several years after, but there were no more leaky flues.

I could cite many other cases where cold air had been admitted to the flue sheet and caused the flues to leak. Letting in cold air will cool the fire down to a certain extent, but most of it passes over the fire. It does not become heated but strikes the hot sheet, causing it to contract and bulge, drawing the sheet on the flues and breaking the joints, so to speak, where they are expanded.

As an illustration of this bulging take a piece of iron or steel, heat it, pour some cold water on the side of it and notice the effect. The cold air has the same effect on the tube sheet, and if a boilermaker examines the boiler closely he will see that the head has bulged. Let him take the flue out and replace it with a new one, and he will see that it has to be longer than the one he took out when it was new. I have seen them where they would have to be ½ inch longer and also, where they were beaded, pull the beading off.

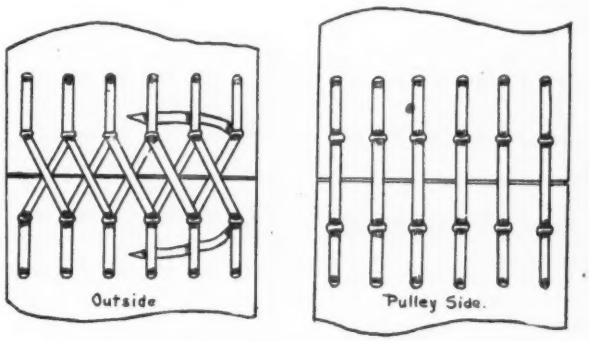
All good firemen keep the furnace doors closed as much as possible.

North East, Pa. B. M. M.

Lacing for a Canvas Belt.

Editor PRACTICAL ENGINEER:

To what was published in your December issue concerning laced belts, let me add the method herewith submitted:



I have been using this style lacing in a 30-inch 10-ply canvas belt transmitting 250 horse-power, and it is giving excellent satisfaction.

Clearfield, Pa. S. B. S.

Cold Air Does Hurt Boilers.

Editor PRACTICAL ENGINEER:

In reply to C. W. B. McC., Kenosha, Wis., December issue of the PRACTICAL ENGINEER, is it injurious to boilers to open furnace doors and admit cold air, Mr. C. W. B. McC. is correct. It is an evident fact that it is, not that I ever practice it, but common sense should teach a man different. I will relate an instance. A short time ago I was called on to repair some leaking tubes. On entering the boiler-room I found the furnace door open. I asked the fireman and engineer in charge if they made a practice of throwing their doors open. Every time it got a little warm they informed me that they did. I told them that accounted for their trouble. By opening the furnace door and admitting a rush of cold air causes a sudden contraction; the tubes being of lighter material, of course, contracts more rapidly than the tube sheet, causing them to loosen and consequently leak. Not only is it injurious to the tubes and boiler plates, but very injurious to your employer's coal pile, as well. In case of a sudden shut down do not open your doors, but close your drafts, cover your fire with ashes and turn on your injector or pump at short intervals to keep up circulation in the boiler, thus preventing the plates from becoming overheated.

Park City, Utah. W. R. S.

QUESTIONS and ANSWERS

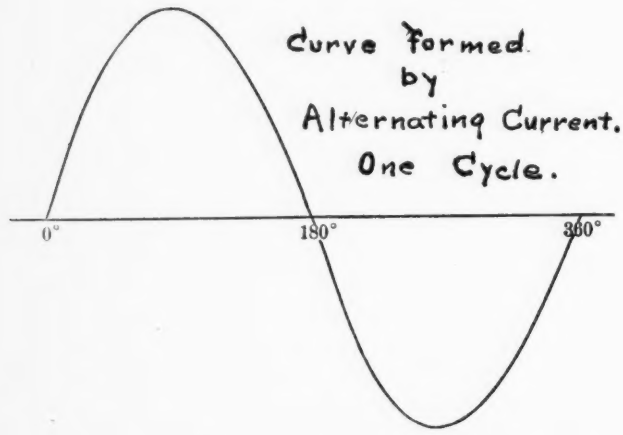
THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers and questions, he especially desires the readers in such cases to contribute any further information, in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communication.

Editor PRACTICAL ENGINEER:

Please give in your next issue of the PRACTICAL ENGINEER the meaning of the word cycle as employed in alternating dynamos and transformers. I mean, for instance, in a transformer of 5 kilowatts, 2,200 volts primary, and 110 to 220 volts secondary and 125 cycles. What does the word cycle mean?

New Iberia, La. W. L. B.

An alternating current is one which changes its direction of flow at regularly recurring intervals, varying from zero to a maximum and decreases to zero, then to an equal maximum in another direction, and then back to zero again. In doing this it is said to have completed a *cycle*. That is to say, it has returned to the condition from which it started and is prepared to repeat the same process, making a second cycle. All alternating current systems are rated according to the number of cycles the dynamo generates in one second. In the case given, 125 cycles means that the current vibrates from zero to zero, as explained, 125 times per *second*. The number of cycles that a dynamo generates depends upon the number of poles and the speed. For power purposes a low number of cycles per second is desired, but for lighting they must be increased, so that the lamps do not show the vibration of a low frequency or low number of cycles.



The accompanying illustration shows a complete cycle. The current starts at zero and rises to a maximum, then decreases to a maximum in the other direction, and then comes back to zero, ready to repeat this cycle.—[ED.]

Editor PRACTICAL ENGINEER:

I have two boilers of the tubular type. One is 150 horse-power and the other 75 horse-power. Will you please inform me how much stack is required to burn coal required in these boilers?

Bradford, Pa. D. W. B.

The height of chimney required in any case, varies with the fuel. Wood requires the least height, then bituminous coal and fine sizes of anthracite require the greatest height of chimney. It also varies with the character of the boiler, the smaller and more circuitous the gas passages the higher the stack required, and also with the number of boilers, a single boiler requiring less height than several boilers of the same horse-power.

The number of pounds of coal which can be burned in a given time on a given grate equals the weight of air forced through, divided by the number of pounds of air required for the combustion of coal under the different conditions. This amount may vary from that theoretically necessary up to an amount 100 per cent. in excess. The weight of the air forced through in the given period of time is equal to the area through which it is admitted, multiplied by its velocity and by its weight per unit of volume.

To impart this velocity, and also that through the furnace, boiler tubes, smoke flue and chimney, there is necessary a pressure which may be approximately ascertained by calculation, but can only be accurately ascertained by direct experiment.

The generally accepted formula of Mr. William Kent, has been very generally adopted in the design of chimneys, and is based upon the observed conditions in a large number of boiler plants. His formula reads as follows:—

$$h = \left(\frac{0.06\ F}{A}\right)^2$$

in which A = area of the chimney in square feet.
h = height of chimney in feet.
F = pounds of coal burned per hour.

In using this formula the area must be assumed and the height found, or the height must be known from which the area is calculated.

In the above problem, we will assume that 5 pounds of coal are burned per horse-power per hour and the area of the chimney is 10 square feet. As the boiler capacity is 225, this makes the value of $F = 5 \times 225 = 1125$ pounds of coal burned per hour. Then substituting in the formula

$$h = \left(\frac{0.06 \cdot 1125}{10}\right)^2 = 45\tfrac{1}{2} \text{ feet.}$$

That is, the height of the chimney must be $45\frac{1}{2}$ feet and area 10 square feet.

If the chimney contains an area of 6 square feet, then the height must be

$$h = \left(\frac{0.06 \cdot 1125}{6}\right)^2 = 126 \text{ feet.}$$

Editor PRACTICAL ENGINEER:

Will you kindly answer the following questions:

(1) If a boiler has two safety valves, one of two inches in diameter and the other four inches in diameter, what would

be the total pressure on each valve if the boiler carried 100 pounds of steam?

(2) What is the temperature of the water in a boiler carrying 70 pounds of steam?

(3) What is the generally accepted water evaporation per standard boiler horse-power per hour?

(4) Will you give me a rule for finding the velocity of steam through a pipe of given diameter and under a given pressure?

New York, N. Y. W. G.

(1) The total pressure on a safety valve is obtained by multiplying the area of the valve by the pressure per square inch. The area of the valve is found by squaring the diameter and multiplying by the constant .7854.

Area of valve 4″ diameter=4x4x.7854=12.56 square inches.

Area of valve 2″ diameter=2x2x.7854=3.14 square inches.

As the pressure per square inch is 100 pounds; the total pressure on the 4″ valve is 12.56x100=1256 pounds, and the total pressure on the 2″ valve is 3.14x100=314 pounds.

(2) The temperature of the water in a boiler carrying 70 pounds per square inch pressure is 315 degrees Fahrenheit.

(3) The standard boiler horse-power is now determined by what is known as the Centennial Rating, which was adopted in 1876 by a committee of judges of the Centennial Exhibition, and is now the accepted standard. According to this, a horse-power is 30 pounds of water evaporated into dry steam per hour from a feed water temperature of 100° Fahr., and under a pressure of 70 pounds per square inch above the atmosphere.

(4) It is not considered good practice to allow a velocity of live steam in a pipe greater than from 6000 to 8000 feet per minute, and in the exhaust pipe a speed of 5000 feet per minute should not be exceeded. To find the velocity in a pipe, if the quantity of steam being used is known, the velocity can be calculated by dividing the quantity of steam in cubic feet by the area of the pipe in square feet.—[Ed.]

Editor Practical Engineer:

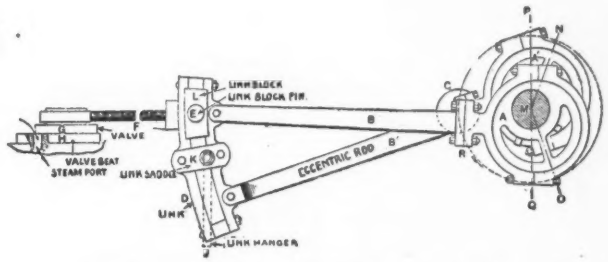
Please answer through your paper, how to set a double eccentric slide valve with a link motion so as to shorten the lead as you notch the lever up near the center. It is a reversing engine, as used in a locomotive, only instead of having it increase the lead as you notch up, have it decrease the lead.

Drew, Maine. E. I. L.

The valve motion that you mention is known as the Stephenson link motion. It consists of two fixed eccentrics and two eccentric rods connected to a link. The valve then derives its motion from each eccentric, so that when the lever is in its far notch from the centre one eccentric moves the valve, and when the lever is reversed the other eccentric moves the valve. When under the action of either eccentric, the valve has the movement of any simple slide valve engine. When, however, the lever is in any other position it moves the block in the link so that the valve motion is a combination of the two motions, until when the lever is in its central position, the valve has no effective movement at all.

There are two ways in which the eccentrics are connected to the link, the arrangements being known as open rods and crossed rods. The rods are said to be open if they are open when the eccentric centres are on the same side of the shaft as the link and valve. The term crossed rods is used when the eccentrics are crossed—when the eccentric centres are on the same side of the shaft as the link and valve.

At a glance it may not be apparent whether the rods are crossed or open, but upon examination it can be seen that the action on the valve is different. With the open rod arrangement the valve lead is increased, as the block approaches the centre of the link, or as you notch up.



Stephenson's Link, with Open Eccentric Rods.

The only way to partially overcome this difficulty with the open rod arrangement is to change the angle of advance or make the angle of advance of the two eccentrics different. This will equalize the lead when the engine is running in one direction only, so that they can be set so that it decreases the lead, is the position of link at which cut-off it is to be used.

When the Stephenson link has crossed eccentric rods, the lead decreases as the lever is notched up, so that if you make your engine run with crossed rods instead of open ones, as is now the case, you will obtain the desired results, or if you change the angle of advance of one of your eccentrics as the rods now are, it will equalize the lead when the engine is running in one direction.

The link motion shown in cut is so connected that the lead increases as the link is shifted toward the centre. If the eccentrics rods be oppositely connected to the link, the rods will be crossed and the engine will run in the opposite direction for a given lever position and the lead of the valve will decrease as the lever is shifted toward the centre.—[Ed.]

Editor Practical Engineer:

Will you kindly explain the correct method for finding the amount of water used by an engine per horse-power per hour.

East Falls, Pa. F. MacI.

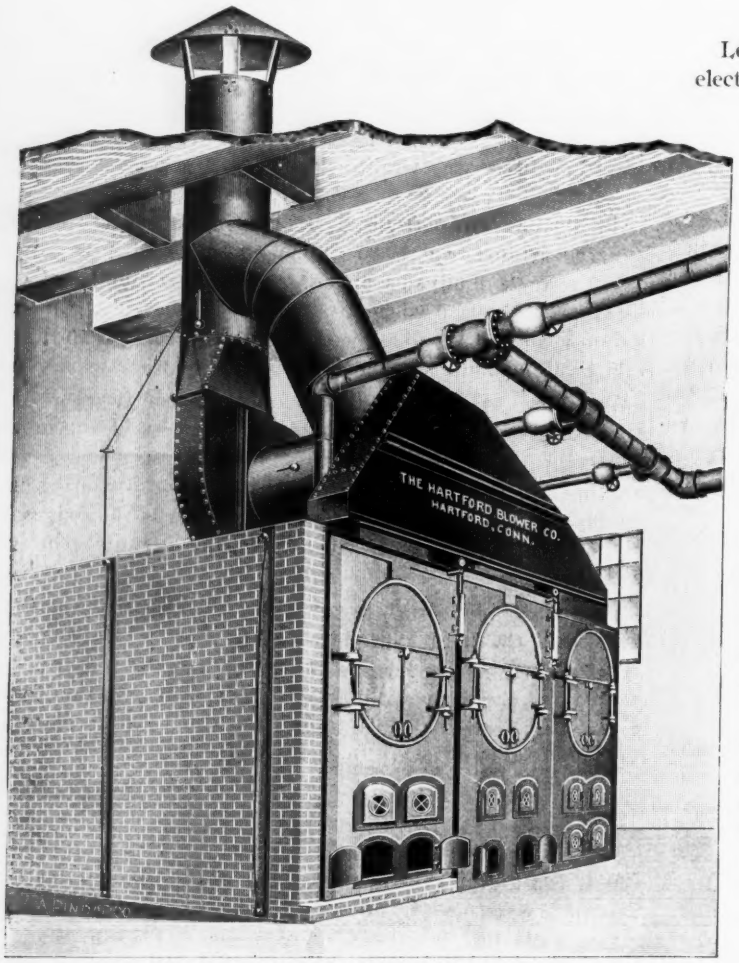
The answer to this question will be found upon another page of the Practical Engineer, and was written to answer this and other inquiries about the same subject.—[Ed.]

Third Annual Ball.

The John M. Phillips Association of Mechanical and Stationary Engineers, of Newark, N. J., gave their third annual reception and ball for their sick benefit fund on November 2d. There were 150 couples present, it being the largest yet given. The grand march was led by Miss Mamie Bonmatt, and Secretary Chas. Kelley. Refreshments and a light lunch were served. For a young organization this one is most successful, having now 160 members.

The "Hartford" Special Steel-plate Fans, for Mechanical Draft.

The increasing adoption of the fan in place of the chimney for draft production has led to the special design of fans for this purpose. They may be applied in either of two ways: for forced draft, where the air is forced into the ashpit and an excess of pressure maintained therein; or for induced draft, where the hot gases are drawn through the fan and a partial vacuum created above the fire. Which method is to be applied must depend upon the conditions, but evidently the fan should be designed in accordance with the method of application.



The application of mechanical draft insures many economies, impossible to attain with a chimney. By means of a fan an economizer may be employed and the draft maintained, thereby greatly increasing the efficiency of the plant, cheaper grades of fuel may be used and the rate of combustion may be increased. The draft is made flexible yet positive, and its intensity may be exactly adapted to the requirements. The fan may be readily applied to increase the steaming power of an existing plant, and as a substitute for a chimney is far less expensive. Its capacity may be changed by merely changing the speed of the engine; it is portable and readily adaptable to new conditions.

There are many ways of applying mechanical draft, and each particular case will need careful consideration to secure the best results at the least outlay.

In the Hartford system particular attention is paid to all parts entering into its construction, and the utmost care is exercised in its application, believing that where skill and integrity is employed success is bound to follow.

The Hartford Blower Company, 128 Suffield street, make a specialty of installing mechanical draft, both forced and induced, as well as installing systems for heating and ventilating, dry-killed exhausters and blow-pipe systems, for handling shavings, saw-dust, lint, etc., and manufacture blowers, exhaust fans, dust collectors, counter shafts, blast gates, etc.

A letter addressed to them will receive prompt attention.

Lehigh Council.

Lehigh Council, No. 15, A. O. S. E., of Allentown, Pa., have elected the following officers for the term commencing January 1st: Past Chief, Henry C. Snyder; Chief Engineer, John T. Lindstrom; Assistant Engineer, C. J. Keiser; Recording Engineer, A. J. Strauss; Corresponding Engineer, A. P. Dreisbach, 728 Chew street; Financial Engineer, Jacob Donnecker; Treasurer, Engineer John Burley; Chaplain, Henry Dieble; Senior M. M., Hiram Roth; Junior M. M., W. F. Stahler; Inside Sentinel, Killian Engles; Outside Sentinel, Edmund Brader; Delegate to Grand Council, Wm. R. Smith; Alternate, John Durrin.

Progress Council.

Frank S. Miller, instructor for Progress Council, No. 13, at Reading, Pa., continues to make the meetings of that Council very interesting. At the meeting on December 12th, Mr. Miller gave an instructive lecture on the "Economy of the automatic cut-off over the plain slide valve," which was appreciated by all. On the same evening two new members were initiated and some other applications received.

W. H. Ermentrout, manager for Bright & Co., of Reading, recently presented the Council with a handsome model of a plain slide-valve engine which is very useful for instructive work. The cylinder is $2\frac{1}{2}''$x5", and the bed 26" long.

A. Edw. Rhodes, author and publisher of *Mechanical Drawing*, has removed to 1510 W. Sixth Street, Wilmington, Del. *Mechanical Drawing* is a useful booklet for schools and self-instruction. Seventy pages, 7x9 inches, flexible cloth cover. Price, 50 cents.

It teaches the use and care of instruments, geometrical terms used in drafting, lettering, study of working drawings, and elementary machine design, including working drawings and formula for pulleys, wheel gearing, a 6"x"6 steam engine, 12" swing lathe, and a 3"x$2\frac{1}{2}$" pump.

To find the diameter of a pump cylinder to move a given quantity of water per minute, divide the number of gallons by 4, then extract the square root, and the product will be the diameter in inches of a pump cylinder required to do the work at a piston travel of 100 feet per minute.

A Text-book on Commutator Construction.

An instructive series of papers has just been published by the Derry-Collard Company, of 256 Broadway, New York. Number three of this series is entitled "Commutator Construction," written by William Baxter, Jr. It describes very clearly the construction of the commutator, both large and small ones, long and short ones. Different shapes of commutator sections are discussed, and the insulation and clamping of sections are clearly shown. An important chapter on the repairing of commutators is especially valuable, as this is one of the most troublesome parts of the constant-current-dynamo or motor. This pamphlet contains thirty-nine illustrations. Price, 25 cents.

Sexton's Boilermakers' Pocketbook.

It is sometimes customary with authors to apologize for offering a new work to the public. In this case it is not necessary, as it supplies a want that has been long and earnestly felt.

The author, Mr. Maurice John Sexton, has been a practical man for many years, and he compiled for his own use a Pocketbook of Tables to avoid having to make long calculations the moment they were wanted. These are embodied in the Pocketbook, to which have been added the results of upwards of twenty years' experience among the manufacture and working of boilers.

It is, indeed, a matter of no little surprise that a plain and practical work on boilermaking has never before been written. So that this book is intended to remedy this defect, as the writer has in common with thousands of others often felt the need of a pocketbook of reference like the one just published. It is, therefore, intended to make it all that could be desired to give the mechanic a thorough knowledge of his business.

Steam users will also find this work very useful, as it will show them where to look for hidden defects, and their cause and means of prevention. The book also describes the strain put upon boilers in trying to make one part fit another which has not been properly prepared to receive it, depending entirely upon the elasticity of the iron to force or drag the parts together, which a very little extra pressure would cause to fly asunder. The book is clear and the possessor of it will be saved the labor of making many calculations—a thing always objectionable during the hurry and excitement of working hours. He will find in the pages an answer to nearly every question that in the ordinary course of business can possibly suggest itself.

Spon and Chamberlain, of 123 Liberty Street, New York, are the publishers, and the price is $2.00.

Filling Cracks in Castings.

Many methods for closing cracks or pores in cast iron have been devised. Chemical or other products, such as salammoniac, are often used to cause the formation of iron salt, easily oxidizable, which in a short time gives a certain quantity of hydrated oxide of iron. This is made use of very often to stop up leaks which develop in metallic cylinders. This method is, however, a somewhat lengthy one, several days being oftentimes necessary to obtain satisfactory results; that is to say, entire absence from leakage. A method of closing cracks or pores has lately been devised by M. A. Demalght, of Brussels. The cylinder is filled with a certain quantity of perchloride of iron. The liquid is then compressed until globules appear on the external surface. The cylinder is then impregnated with perchloride of iron right through, as regards its thickness. Any perchloride in the cylinder is then emptied out, the cylinder being then wiped until the polished surface is again made brilliant.—*Iron Trade Review.*

Manayunk Council.

Manayunk Council, No. 9, A. O. S. E., has elected the following officers for the ensuing year: Chief Engineer, Walter Guie; Assistant, Geo. Arnold; Recording and Corresponding Engineer, John Clevenger, 211 Lofty street; Financial Engineer, Geo. Carpenter; Treasurer, Wm. J. Beatty; Senior M. M., J. L. Scharff; Junior M. M., Valentine Dutton; Chaplain, Nories Warner; Inside Sentinel, Geo. Richardson; Outside Sentinel, John Hill.

Secretary of the "state" writes us that the Council is doing fine according to the times, but that Manayunk is a dull place when the big Pencoyd Iron works are on short time. But he adds, "Come out to the Council on the 8th of January: there will be something doing." So we guess we'll go.

A Large Power Plant in London, England.

Operations Will Cost Over $6,000,000 and Most of the Machinery will be Purchased Here.

American interests have secured the contract for the electrical and steam equipment for the large power station now under construction at Chelsea, London, S. W., for the purpose of generating current to operate the extensive system of underground and surface lines in and around the British metropolis. The Chelsea power station will be the largest plant hitherto built on either side of the Atlantic for furnishing current for electric traction. The initial capacity will be no less than 75,000 horse-power. There will be ten steam turbines of 7,500 horse-power capacity each. The generators will have a normal rating of 5,500 kilowatts. The boiler equipment will be of Babcock and Wilcox build. The cost of the power-house will be about $6,250,000. The plan is designed with a view to increasing the capacity by a half. The contract for the motor equipments will mean the expenditure of nearly $3,000,000. General Electric and Westinghouse equipments have been on trial for the last twelve months on one of the lines running near London. The motors for each of the 480 cars to be used on all the lines will aggregate 500 horse-power.

To convert the Metropolitan District Railway from steam to electricity and to construct and take over the various other lines in and around London in which the Underground Company is interested, no less a sum than $85,000,000 will be expended, half of which will be American capital.

TRADE NOTES

With a trial order for a small quantity of "P. P. P." Packing sufficient for a test of quality the Quaker City Rubber Co., Philadelphia, will send one of their steel packing rules, free.

The Dearborn Drug and Chemical Works, Rialto Building, Chicago, Ill., have issued a handsome large calendar for 1904, which they will send to any engineer mentioning THE PRACTICAL ENGINEER.

John T. Lindstrom, 216 S. Third Street, Allentown, Pa., has issued a handsome calendar for 1904, which he will mail to any engineer upon request. Mr. Lindstrom manufactures the Lindstrom Steam Trap, the Lindstrom Separators and other specialties. He also does all kinds of engine and pump repairing.

Firing shavings and saw dust is reduced to a science by the use of the Sterling Automatic Furnace Feeder, built by the Sterling Pipe and Blower Manufacturing Co., Hartford, Conn. This feeder is decidedly cheaper, cleaner, more reliable and more effective than hand firing. It uses much less fuel and by keeping a more even temperature it preserves the boilers.

This company also make Sterling exhaust heads.

The Hartford Blower Company, of 128 Suffield Street, Hartford, Conn., have gone to press with a new catalogue. The title will be, "The Hartford Blowers & Exhaust Fans, Sectional Catalogue." It will illustrate and describe the well-known Hartford Patent Improved Adjustable Blowers & Exhaust Fans, Steel Plate Steam and Pulley Fans, Disc Fans, Counter Shafts, Blast Gates, Dust Collectors, etc.

It will be printed on good paper; well bound with a nicely designed cover.

The Hartford Blower Company, who are mechanical experts in the removal of shavings, saw dust, etc., and make a specialty of installing heating, ventilating and mechanical draft apparatus, will be pleased to send one of the new catalogues as soon as issued, free of charge, to any one interested. Mention THE PRACTICAL ENGINEER.

James McCrea & Co., Manufacturers of steam specialties, 67 W. Washington St., Chicago, have recently placed complete stocks of their Climax Steam Joint Clamps and the H. H. Steam Trap with Thomas Somerville & Sons, Washington, D. C., and the S. M. Price Machinery Co., Norfolk, Va. There is hardly a city in the United States that has not one or more dealers that can supply these clamps up to 12 inches, and the traps in all sizes, from stock.

This is a point worth noting, for when you need climax clamps you generally need 'em quick.

The Corliss Engine Works, of which Geo. Richards is the well-known manager, and which has been a land-mark at the corner of Howard and Huntington Sts., for many years, has removed to Fifth Street, above Luzerne Street, where they have erected a handsome, large new building, equipped with every modern tool and facility required in a first-class engine shop.

A new catalogue has just been published by Richard Thompson & Co., which will be sent gratis to any engineer interested in the many steam specialties shown therein. These include the Thompson Damper Regulator, Indicators, Reducing Wheels, Grate Bars, Flue Cleaners and a variety of other specialties, all of special interest to the man in the steam plant. Write for one at once.

Pneumatic Tools and their many uses are described and illustrated with numerous half-tone engravings in a small booklet published by the Chicago Pneumatic Tool Co., Fisher Building, Chicago, Ill. Copies will be mailed upon request to those mentioning THE PRACTICAL ENGINEER.

The Hartford Blower Company, of Hartford, Conn., manufacturers of the Hartford Improved Adjustable Blowers and Exhaust Fans, have just received another order from the L. S. Starett Company, of Athol, Mass.

This is the third order from this firm, and coming as it does from a conservative firm, who purchase only the best improved machinery, is a flattering testimony of the excellent quality, workmanship and efficiency of the Hartford Improved Adjustable Blowers and Exhaust Fans, as well as the Hartford Exhaust System and Mechanical Draft Apparatus.

April 5th, 1900, the Rochester Stamping Co., wrote to the Stephenson Manufacturing Co., Albany, N. Y., for a free sample of Stephenson Bar Belt Dressing. April 14th, 1900, ordered 12 lbs. Stephenson Bar Belt Dressing; June 30th, 1900, ordered 100 lbs.; March 2d, 1901, 200 lbs.; Feb. 3d, 1902, 300 lbs.—100 lbs. for a neighbor; Oct. 3d, 1902, 300 lbs. for themselves; Oct. 20th, 1903, 200 lbs. for themselves, making a total of 1112 lbs.

From the above it seems clear that no salesmanship is required. The sample does its own talking.

A sample bar will be sent to any reader of THE PRACTICAL ENGINEER upon request.

The Kingsford Foundry and Machine Works, of Oswego, New York, are specialists on the manufacture of Centrifugal Pumps. The Centrifugal Pumps of their manufacture are the only ones now on the market with single or side suction, that contain the such important features as self-oiling bearings, solid shells, removable suction head, which permits examination of the interior of the pump without removal of the same from the base, large shafts and pulley and an improved stuffing box that will remain tight under the most trying conditions. They also have a complete boiler plant, and make a specialty of the manufacture of internally fired boilers, and any inquiries about boilers, pumps or engines are solicited.

The Clark Safety Water Column is meeting with high favor among engineers. The Clark column is attached to the boiler in the usual manner. Its operation is based on the most reliable of forces, gravity. Owing to the leverage obtained from the long floot arm, the safety alarm is said to be positive under any pressure.

These columns are manufactured by Aaron Miller, Vicksburg, Michigan. A representative of THE PRACTICAL ENGINEER visited Mr. Miller's factory recently, and saw the columns tested. He was also shown shipments of these columns going out to all parts of the world.

An illustrated circular will be mailed upon request.

Every engineer knows, if he stops to think, that packing a piston rod makes friction, but how much that friction costs in dollars and cents, and how much of it may be stopped by simply using the right kind of packing, very few know.

The Quaker City Rubber Co., of No. 409 Market Street, Philadelphia, Pa., have issued a very interesting booklet which will be sent free to engineers upon request which describes this very clearly.

The subject of friction, consequently lost power, caused by packing, has not received as much attention as it should, and not only is this explained clearly, but many troublesome moments may be avoided by the application of some of the principles taught in this booklet.

Are you using your exhaust steam? If not, you are wasting coal, water and money. Many letters to this effect have been received by the Standard Steam Specialty Co., 542 West Broadway, New York. They are the makers of the well-known "Utility" Steam Specialties. Among many of their appliances for saving steam, may be mentioned the "Utility" combination Muffler Tank, Oil Separator, Return Tank, Pump Governor and Feed-water Heater, which is guaranteed to extract 98 per cent. of all the oil in exhaust steam. This combination not only saves the oil but saves space, coal, water, first cost and maintenance. Besides this valuable combination they also supply separately, the "Utility" Pump Governors, High-Pressure Boiler Feeders, Back-Pressure Valves, Pump-Governor Valve, Steam Separator, Exhaust Heads, Oil Separators, etc.

An impressive fact mentioned by the Heisler Pumping Engine Co., of Pittsburg, Pa., is that there is not a more wasteful piece of machinery on earth than a direct-acting steam pump of usual construction. Purchasers of these pumps have profited not only in saving fuel, but another decided advantage of the Heisler High-Duty Pumping Engines is that while they have three times the capacity of the discarded pumps, they do not require any more space. This same firm is also manufacturers of the Heisler High-Duty Blowing Engine and the Heisler High-Duty Air Compressors. A handsome and instructive catalogue will be mailed to any one interested who mentions THE PRACTICAL ENGINEER. Address Heisler Pumping Engine Co., Westinghouse Building, Pittsburg, Pa.

With the introduction of high pressure steam has come a demand for proper chimney facilities. This has been met by the system of constructing radial brick chimneys, a method which is not only ornamental in the highest degree, but it is also satisfactory in filling requirements. Those interested in present day methods of chimney construction will receive a handsomely illustrated catalogue upon the subject by addressing H. R. Heinicke, builders of factory chimneys, 160 Fifth Ave., New York City, with mention of the PRACTICAL ENGINEER.

The Loomis Pettibone Company, 52-54 William St., New York City, engineers and constructors of power plants, announce that they have increased their capitalization to $2,000,000, and will be known in the future as Loomis-Pettibone Gas Machinery Company. They are now constructing a large plant for the manufacture of gas enignes in large units, and will also deliver the engines manufactured by Crossby Bros., Ltd., of Manchester, England.

The Homestead Valve Manufacturing Co., of Pittsburg, Pa., have installed a complete iron foundry, which was started Dec. 7th in conjunction with their brass foundry. This company claims to excel in the production of both brass and iron through the use of converting furnaces, in which a heavy blast is used, the process resulting in purer and better metal than can be produced with crucible or cupola furnaces, thus enabling them to make a superior semi-steel valve. These valves are described and illustrated in the company's booklet "P. E.," which will be mailed free upon request. Address Homestead Valve Manufacturing Co., P. O. Box 1754, Pittsburg, Pa.,

One of the prime requisites for the successful business of to-day is to make quick deliveries, and the "when" is often considered of more importance than the "how much."

To further facilitate the prompt filling of orders, the Sawyer-Man Electric Company have recently established a distribution depot at the Central Stores of the Terminal Warehouse, in West 28th Street, New York. Here are kept over a million lamps in stock, so that any and all calls may be speedily and completely answered.

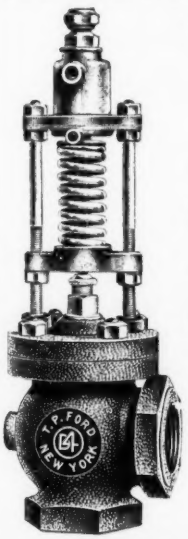
A similar depot is situated at 30th and Market Streets, Philadelphia, and others in Boston, Buffalo, Syracuse, Pittsburg, Charlotte, Chicago, Denver, St. Louis, Atlanta, New Orleans, San Francisco, Seattle and other centres of trade.

The Jenkins Diamond Trap is a simple, inexpensive trap, adopted for heaters in rubber factories, or for any place where not more than 500 or 1000 feet of pipe are to be taken care of. It is an expansion trap, working on the same principle as the Jenkins Automatic Air Valve for Radiators. If illustrated circular is wanted, address Jenkins Bros., 135 N. Seventh Street, Philadelphia.

The A. W. Cadman Manufacturing Co., of Pittsburgh, Pa., have just shipped 128 of Cadman's Indestructible Blow-off Valves to England to be used by the Underground Electric Railway Company, for their large zinerating station at Chelsea Creek. The construction of these valves is interesting, both the seat and the disc being reversible. A catalogue will be mailed to any engineer upon request. Address as above.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 214 and 216 S. 3d St., Allentown, Pa.

THE FORD PUMP REGULATOR



and all STEAM and WATER . . . SPECIALTIES

Manufactured by

Thos. P. Ford Co.

Are now carried in stock in our

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142 North Sixth Street

Philadelphia Pa.

Catalogue and Prices on Application

THE OIL MANUFACTURERS

do not like

CROSS OIL FILTERS

because it cuts their receipts in half.

The Fairbanks Bostom Rim Co., Bridgeport, Pa., say of the Cross Oil Filter: "Our orders for oil dropped off about one-half after putting in your filter."

Let us send the

CROSS OIL FILTER

on thirty days' trial, free. If unsatisfactory, return at our expense.

BURT MFG. CO., AKRON, OHIO

Supplied also by Engine Builders, Oil Companies, and Power Contractors.

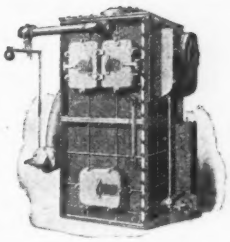
ONE trial makes a habit. The perfect action, with oils generally, of Dixon's Flake Graphite, in small percentages as an accessory lubricant, is so immediately apparent that no mechanic or engineer who has fairly tried a small sample, failed to supply himself with a substantial quantity for constant use.

Your request will bring Booklet 96c and sample.

JOSEPH DIXON CRUCIBLE CO.

JERSEY CITY

COCHRANE FEED WATER HEATERS



Authorities agree that 60 per cent. of the energy in the coal burned under the boilers in a steam plant passes away with the exhaust steam. This constitutes by far the greatest source of waste in the plant, and some means should be provided for using as much of the exhaust steam as possible, so that the heat which it contains can be conserved. The best means for this purpose is a Cochrane Feed Water Heater. One pound of exhaust steam at atmospheric pressure in a Cochrane Heater will heat six pounds of cold water from a temperature of 60° F. (or 9 pounds of water from 100°), right up to the boiling point. In the majority of steam plants there is sufficient exhaust steam available for heating the water to 212°. In some plants there is more than enough, with a constant demand for additional quantities of hot water for manufacturing purposes. If you are now feeding your boilers with live steam injectors, or with water at less than 200° it will pay you to investigate the possibilities of these "Cochranes." Thousands of them (more than 2,000,000 H.P.), are in present use, and we can satisfy you regarding their successful and satisfactory performance. We would be glad to send you upon reject our catalogue 16-H, fully illustrating and describing these Heaters.

Harrison Safety Boiler Works

3144 N. Seventeenth St.

PHILADELPHIA

Manufacturers of Cochrane Steam and Oil Separators and of the Sorge-Cochrane Systems

American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them ; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.-To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then one year's service, in such department, and in localities where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting, to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

SUPREME COUNCIL OF THE UNITED STATES.

Supreme Chief Engineer.—Noah R. Pierson, Fidelity Building, Baltimore, Md.
Supreme First Assistant Engineer.—W. S. Price, Haddon Hall, Atlantic City.
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Delaware Council, No. 1, meets every Wednesday at S. E. Cor. Fourth and King Sts. Chief Engineer, Clark Franklin. Corresponding Engineer, A. E. Deakyne, 406 Lombard St.

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Deputy Supreme Chief Engineer, John W. Angers.

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JENNINGS.

Jennings Council, No. 2, meets every Saturday evening in American Bank. Chief Engineer, Daniel R. Jones. Corresponding Engineer, R. E. Funk.

MARYLAND.

Deputy Supreme Chief Engineer, A. J. Defdrich, 226 North Caroline St., Baltimore, Md.

BALTIMORE.

Maryland Council, No. 1, meets 2nd and 4th Fridays in Royal Arcanium Hall. Chief Engineer, L. Smithers. Corresponding Engineer, Wm. S. Smith, 533 Sharp St., Baltimore.

Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Chesapeake and Elliott Sts. Chief Engineer, T. E. Eaton. Corresponding Engineer, Thos. G. Daneker, 834 East Ave.

MASSACHUSETTS.

Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

BOSTON.

Boston Council, No. 4, meets 2nd and 4th Thursdays of each month, inthe Hall, 262 Washington St. Chief Engineer, A. R. Abbott. Corresponding Engineer, Phillip Sanford.

ROCKLAND.

Old Colony Council, No. 14, meets 2nd and 4th Saturdays in the American Forestere' Hall. Chief Engineer, Herbert W. Jones. Corresponding Engineer, James K. Sedgwick, Box 333, Rockland, Mass.

NEW JERSEY.

Deputy Supreme Chief, F. O. Garrison, Bridgeton, N. J.

PERTH AMBOY.

Stevens Council, No. 1, meets 3rd Saturday, at Water, near Lafayette St. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

CAMDEN.

Camden Council, No. 3, meets every Thursday evening at S. E. corner 2d and Arch Sts. Chief Engineer, S. M. Best. Corresponding Engineer, C. H. Pfeiffer, 571 Berkley St.

ATLANTIC CITY.

Atlantic City, No. 4, meets every Tuesday evening at Merchants, Cor. Atlantic and New York Aves. Chief Engineer, John A. Best. Corresponding Engineer, W. S. Price, Haddon Hall.

BRIDGETON.

Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

MILLVILLE.

Millville Council, No. 6, meets every Saturday, 7.30 P. M., in G. A. R. Hall, East Main St. Chief Engineer, Wm. F. Pond. Corresponding Engineer, Lewis Doughty, 604 Mulberry St.

NEW YORK.

SYRACUSE.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington St. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange St.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1042 Locust St., Reading, Pa. Deputy Grand Chief for Philadelphia and Delaware Counties, John P. Rickards, 2707 N. Broad St., Philadelphia. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna St., Philadelphia.

Deputy Grand Chief for Western Pennsylvania, A. D. Hamilton, 2025 Forbes St., Pittsburg, Pa.

PHILADELPHIA.

Germantown Council, No. 22, meets every Wednesday evening at Main and Seymour Sts., Germantown. Chief Engineer, George T. Lee. Corresponding Engineer, Frank MacIndoe, 3519 Ainsley St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. Twelfth St. and Columbia Ave. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Ave. and Master St. Chief Engineer, Ed. C. Ricker. Corresponding Engineer, Ernest Ritsert, 2229 Frankford Ave., Philadelphia.

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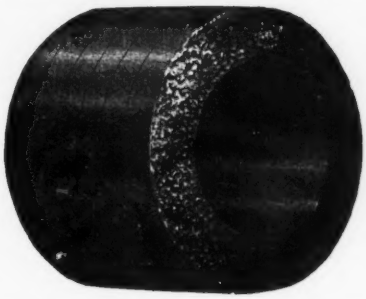

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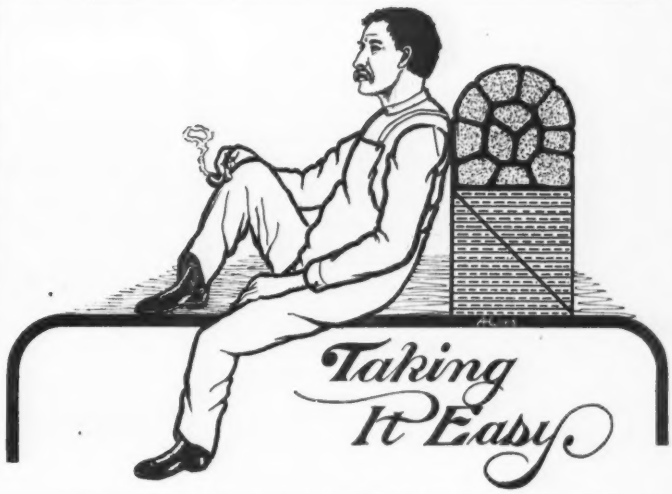

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Philadelphia Council, No. 7, meets every Wednesday, at Kenny's Hall, N. W. Cor. Broad and Filbert Sts. Chief Engineer, Harry Dunn. Corresponding Engineer, W. S. Wetzler, 3717 Aspen St.

Manayunk Council, No. 9, meets 2nd and 4th Friday evenings in Temperance Hall. Chief Engineer, Andrew Roberts, Sr. Corresponding Engineer, John Clevenger, 211 Lofty St.

Helping Hand Council, No. 12, meets every Tuesday evening at the Hall, 2550 Emerald St. Chief Engineer, Edward Laurence. Corresponding Engineer, Frank McHugh, 2503 Tulip St. All correspondence should be addressed direct to the Council.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Sts. Chief Engineer, Daniel Bunting. Corresponding Engineer, Walter Meyers, 1211 North Howard St.

PITTSBURG.

Iron City Council, No. 21, meets every Saturday at Arnfeld Hall, 1119 Penn Ave. Chief Engineer, J. J. Stewart. Corresponding Engineer, Alex. Fraser, Carnegie, Pa.

GIRARDVILLE.

Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, Second and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

ALLENTOWN.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, John evening at 639 Hamilton St. Chief Engineer, Henry C. Snyder. Corresponding Engineer, A. P. Driesbach, 728 Chew St.

POTTSTOWN.

Pottstown Council, No. 14, meets 1st and 3rd Saturday evenings at P. O. S. of A. Hall, Cor. High and Hanover Sts. Chief Engineer, Chas. Quinter. Corresponding Engineer, H. L. Shirey, 362 Cherry St.

READING.

Progress Council, No. 13, meets every Saturday evening at Diebert Hall, Ninth and Penn Sts., Room 4. Chief Engineer, John Kellenberger. Corresponding Engineer, Frank S. Miller, 3 West Franklin St.

CHESTER.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, Sixth and Wall Sts. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West Third St.

YORK.

York Council, No. 16, meets every Wednesday Evening in the Jordan Block. Chief Engineer, A. L. Bair. Corresponding Engineer, Walter H. Long, 23 East Philadelphia St.

HARRISBURG.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market St., above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market St.

COLUMBIA.

Columbia Council, No. 18, meets every 1st and 3rd Saturdays, in Odd Fellows' Hall. Chief Engineer, John McLane. Corresponding Engineer, W. J. Courtney, 804 Walnut St.

SUNBURY.

Sunbury Council, No. 19, meets every Monday evening in Zartman's Hall. Chief Engineer, R. D. Mantz. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn St., Milwaukee.

MILWAUKEE.

Washington Council, No. 1, meets every Saturday at 207 Grand Ave. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed St.

Clifford P. Williams Council, No. 2, meets every Monday evening at Lodge Hall, E. Water St. Chief Engineer, J. T. Harris. Corresponding Engineer, Joseph T. Harris, 1611 Clybourn St.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

NASHVILLE.

Enterprise Council, No. 1, meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

OREGON.

Deputy Supreme Chief Engineer, Nat. Freese, Grant's Pass, Oregon.

GRANT'S PASS.

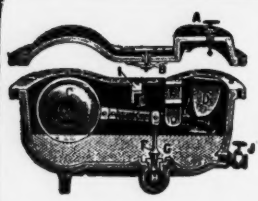
Oregon Council, No. 1, meets every 1st and 3rd Saturday in A. O. U. W. Hall, Main St. Chief Engineer, William H. Kenny. Corresponding Engineer, Nat Freese.

TEXAS.

Deputy Supreme Chief Engineer, S. A. Bisbey, care of Cotton Compress and Warehouse Co., Galveston.

GALVESTON.

Galveston Council, No. 1, meets every 2nd and 4th Tuesday evenings at Engineers' Hall, S. W. Cor. Twenty-second and Strand Sts. Chief Engineer, Max Levy. Corresponding Engineer, A. L. Bradford, Union Depot.



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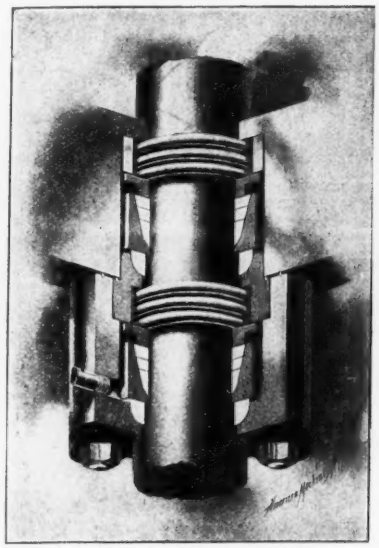

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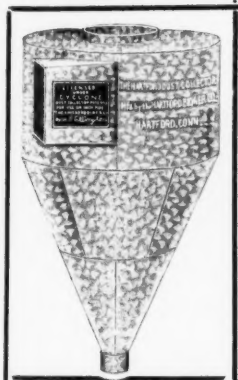

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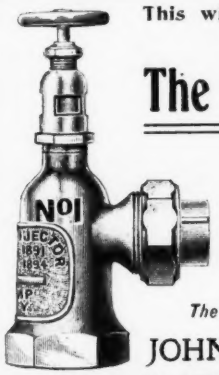

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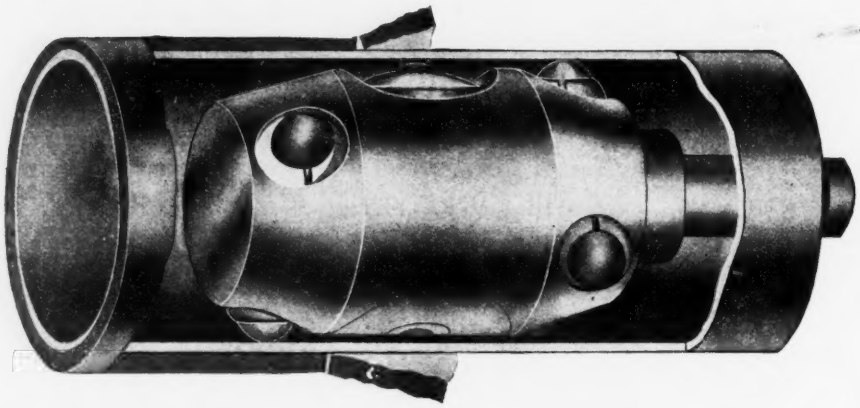

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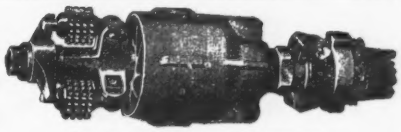

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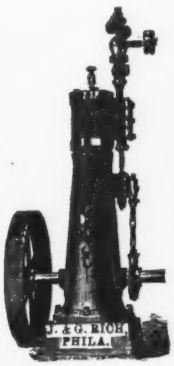

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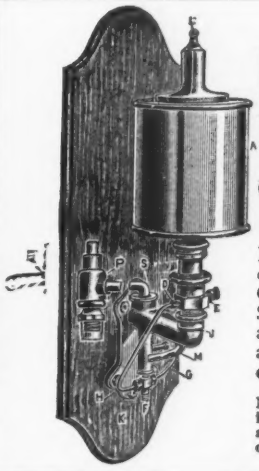

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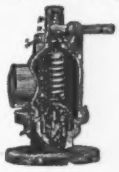

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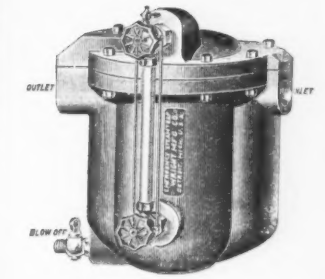

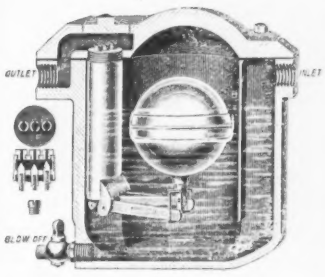

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It is false economy to put a good piston and packing into a cylinder that is out of round. If you put a good house on a poor foundation, both you and the house will be poor in a short time.

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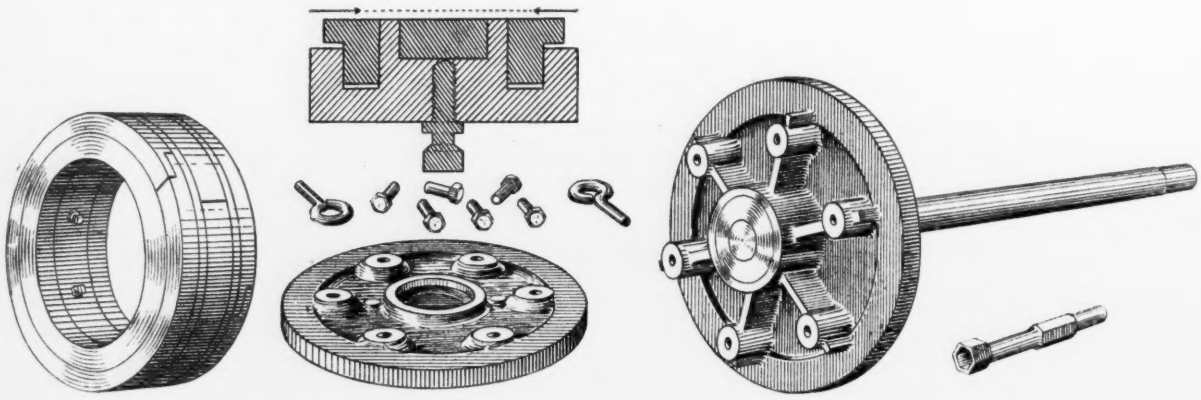

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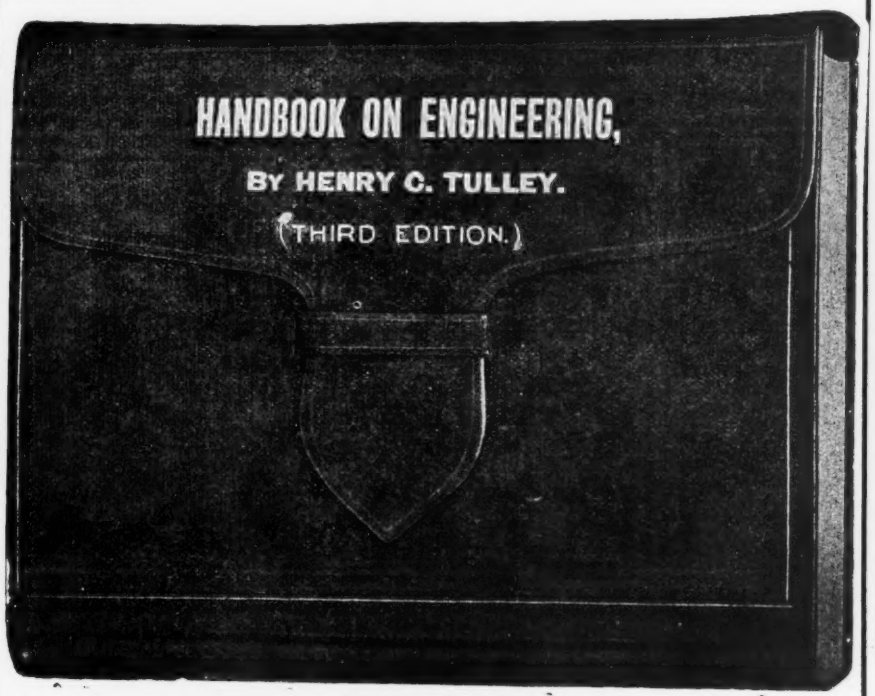

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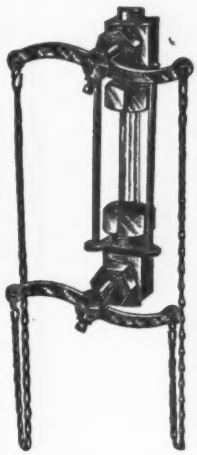

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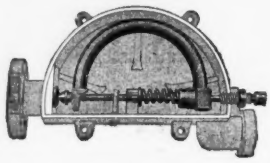

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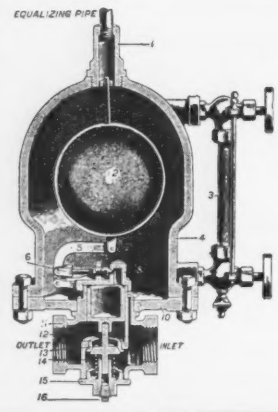

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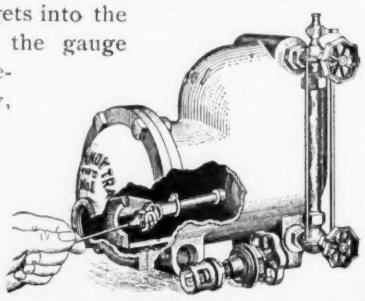

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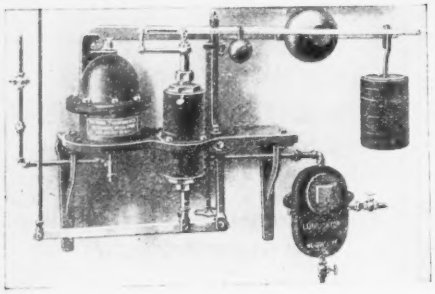

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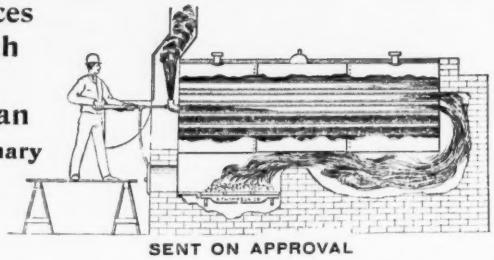

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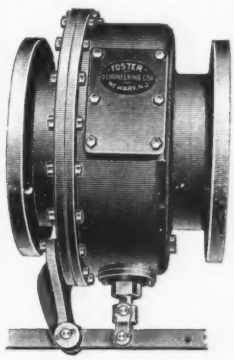

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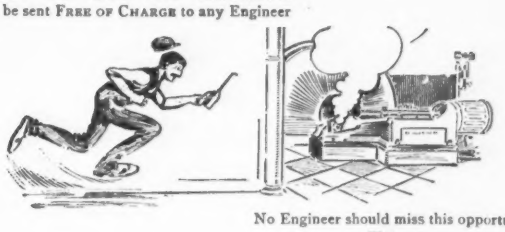

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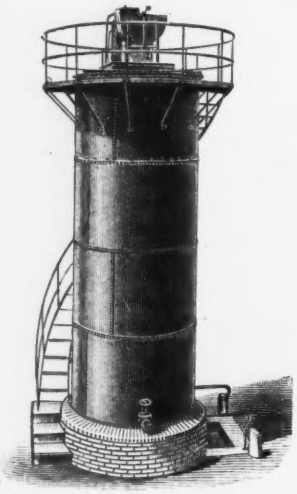

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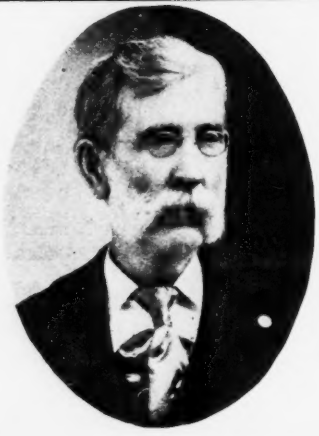

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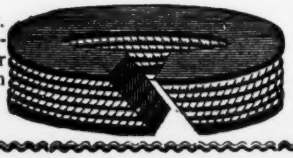

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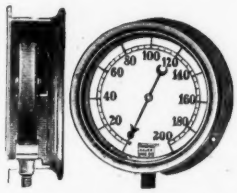

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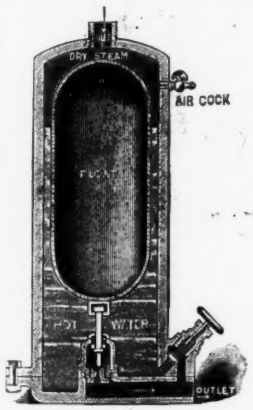

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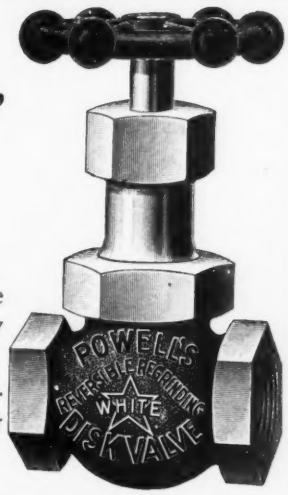

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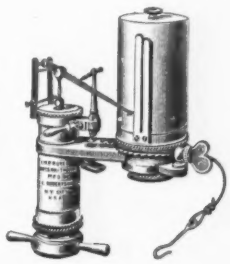

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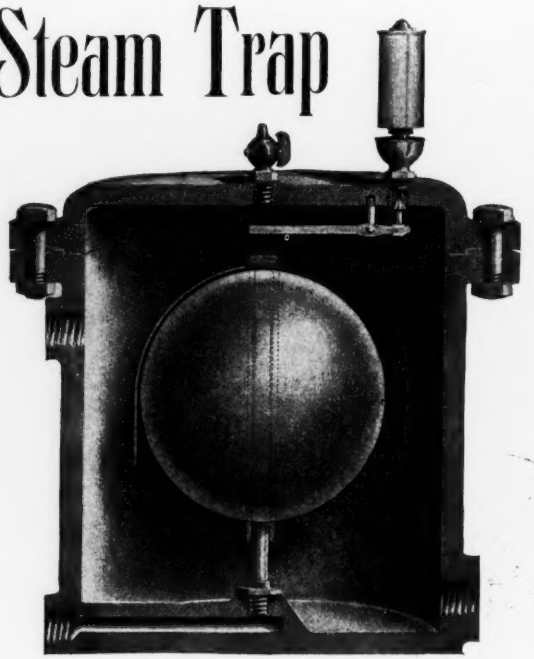

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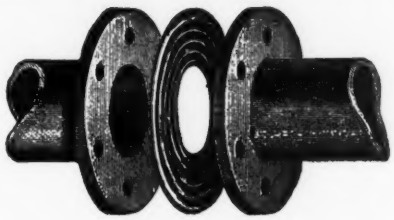

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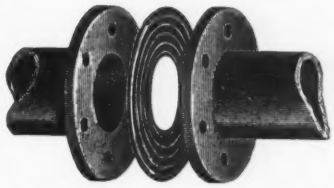

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RED SEAL BOILER COMPOUND

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WILL REMOVE SCALE AND GREASE FROM STEAM BOILERS

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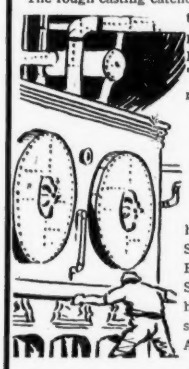
A BAD BREAK.

The rough casting catches and clogs—Snap!—then to the repair shop, while a pressing job hangs fire. Easy enough to prevent. "A stitch in time saves nine."



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has three forms (Putty, Semi-Paste and Paint) for Rough, Less-Rough and Smooth Castings. It fills holes; smooths out; preserves life of castings. All colors. Samples free.

WISCONSIN GRAPHITE COMPANY,
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FOR EITHER HIGH OR LOW PRESSURE

Holds steam, water, air or ammonia with less friction on the rod than any other. Write for trial order to-day.

Watt's Best Sheet Packing

It is best because it makes any kind of a joint tight and keeps it tight. Used for oil, acid, steam, ammonia and water. It is the lightest and purest Rubber Packing made and can be used over again, and will not become hard under the highest steam pressure.

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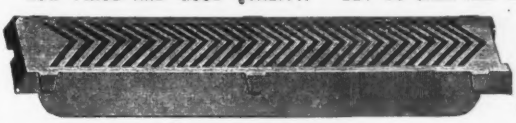

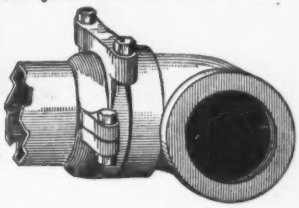

Smith's Clamp for stopping leaks in pipe joints. Cheapest, simplest and most effective Clamp ever manufactured. Costs less than $1.00 per inch in diam. and much less in steel.

W. CLIFFORD SMITH,

Steam Specialties and Castings of Every Description. 140 N. Sixth St., Philadelphia.

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We believe that our new FOUR WEDGE

"Black Squadron" Ring Packing

is superior to any other Packing on the market.

We are willing to back our belief to the extent of placing in the hands of every engineer

A FREE SUPPLY.

We agreeing to pay all express charges and to deliver the package *Free* of *Cost.*

The superiority of "BLACK SQUADRON" RING PACKING is an established fact with us, but what we want to do is to let "BLACK SQUADRON" make a reputation for itself among the men responsible for things in the engine room.

You may find the packing you are now using better than any you've ever used, but from what we know of packing in general we venture to say there's room for improvement. Try "BLACK SQUADRON" and see what it will do. No harm — Costs nothing.

We will also send at the same time we send the packing a valuable little book of information called "The Engineer." Book is also FREE.

Cancos Manufacturing Co.,

146 North Second Street,

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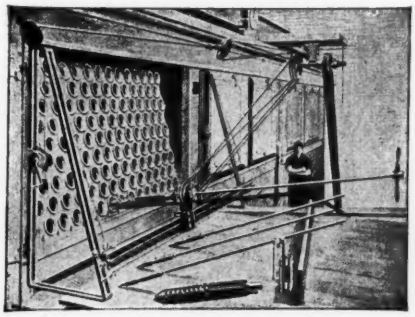

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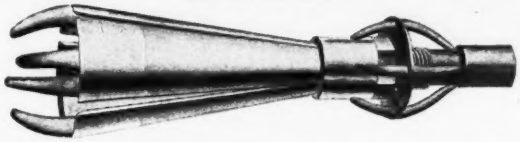
POWER OR IMPULSE

Are the oldest and most efficient Boiler Tube Cleaners on the market. They take out all the scale.



The Gem Flue Scraper

does the same for Smoke Flue Boilers.

We also make **Gem Oilers,** Patent or Plain, **Torches and Heavy Brazed Steel Oilers, Flexible Shafting, Loose Pulley Lubricator.**

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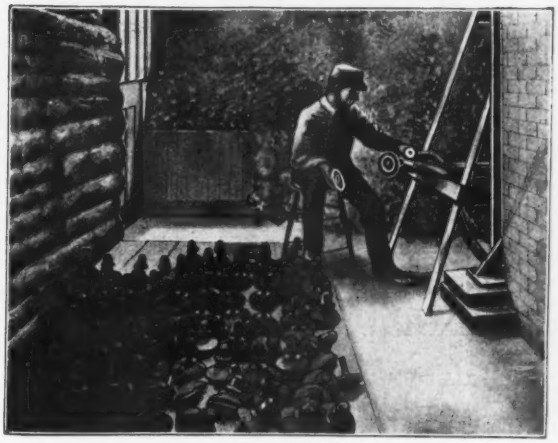
The Lagonda Reseating Machine

FOR CLEANING FACES, NUTS AND CAPS OF BOILER TUBES



IT'S A MONEY-SAVER

Doing in one hour with one operator, work that requires several men many hours. Machine does perfectly what men do indifferently. **No Refitting of Caps Required.** Sent on approval.

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WEINLAND TUBE CLEANERS ARE UNEQUALLED

THE LAGONDA MFG. CO., BOILER CLEANING EXPERTS

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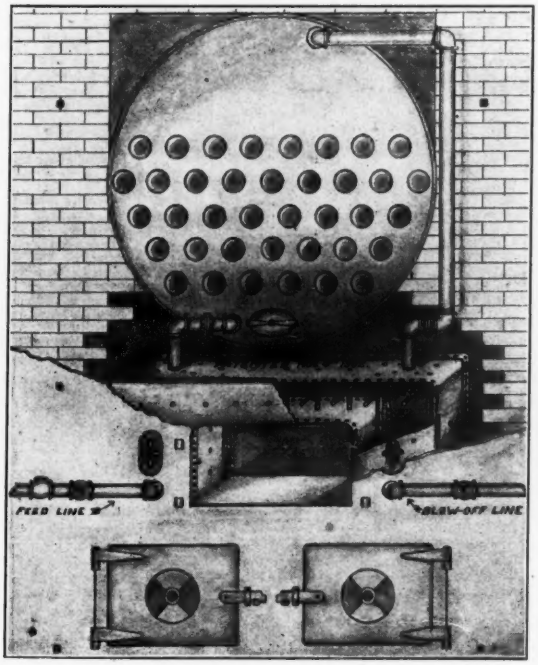

Saves the need of renewing brick arch; lasts as long as the boiler; increases capacity; does the work of a feed-water heater, and saves its cost in coal in a few weeks. You can't afford to be without it.

NEIL W. MAC INTOSH & CO. STEAM FITTERS

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Lamprey Protective Arch Plates

Protect your boiler fronts from burning out, preserve the brick work, save fuel, and increase the efficiency of your boiler, by giving additional heating surface. Save their cost in repairs alone.

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"Teon" Belting

The only belt that will stand **230 degrees** Fanrenheit, **18 degrees above boiling.** It is **water-proof** and not affected by exposure to **chemical actions, etc.** Having enormous strength and splendid driving surface, and being lighter in weight than leather, it will transmit more power than any other belt. For use in exposed places and under adverse circumstances, "Teon" has no equal. Every belt sold with the **guarantee** if not as represented, **money will be refunded.** Send for catalogue showing tests, etc.

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Brown's **Oil-proof** Ring Packing with Imported Compound Cushion and Special Metallic Protection.

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Put into the hot water of the heater or boilers,

Dearborn Vegetable Treatment

It softens the old scale, prevents new scale; and everything that we use is a preservative to iron, connections, etc.

If we are not selling you now, we will, after you get through experimenting, for we know you want:

First—Clean boilers;

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Third—All of this economically.

We will show you all of these.

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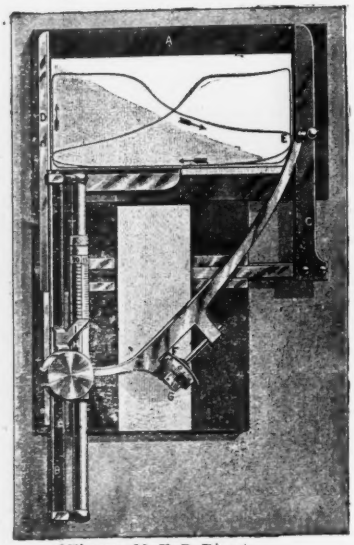

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Compact, Complete in Carrying Case 1½" x 4" x 8"
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Bachelder Adjustable Spring Indicator

Complete for any pressure

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Complete for any Stroke

The Soot Sucker Boiler Tube Cleaner

CLEANS the tubes without admitting steam into them

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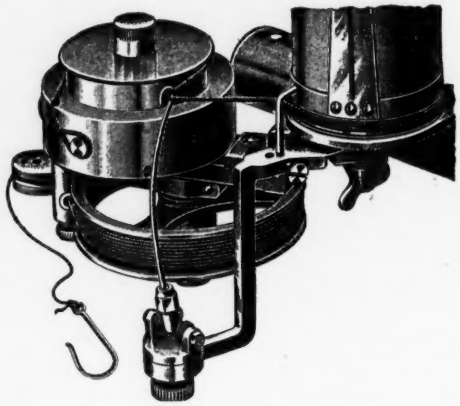
Attached to Bachelder Indicator with Ideal Reducing Wheel

Takes up the slack cord and puts it back where it belongs at the proper time.
No tangling or breaking of cord.



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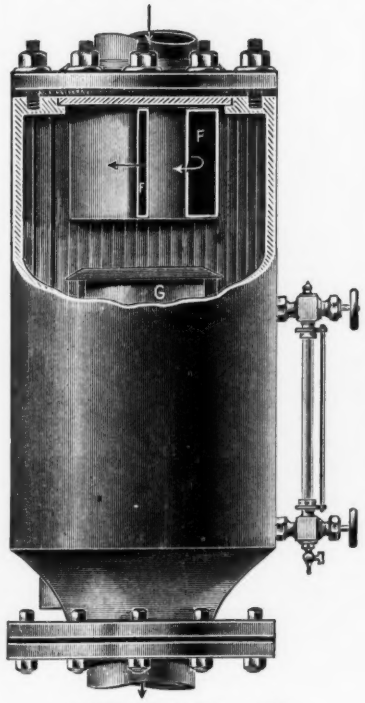
The Sims Steam Separator

FOR VERTICAL PIPE



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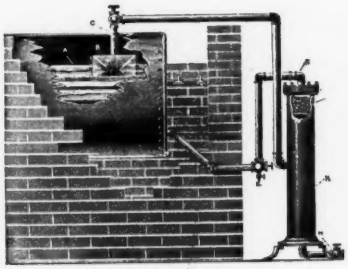
THE

Sims Automatic Boiler Cleaner



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Our prices are low
Our quality high
Our efficiency great
If in need, buy

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Philadelphia Representatives

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—MANUFACTURERS OF—

Mechanical Boiler Cleaners.
Feed Water Heaters.
Oil Filters.
Steam Separators.
Oil Extractors.
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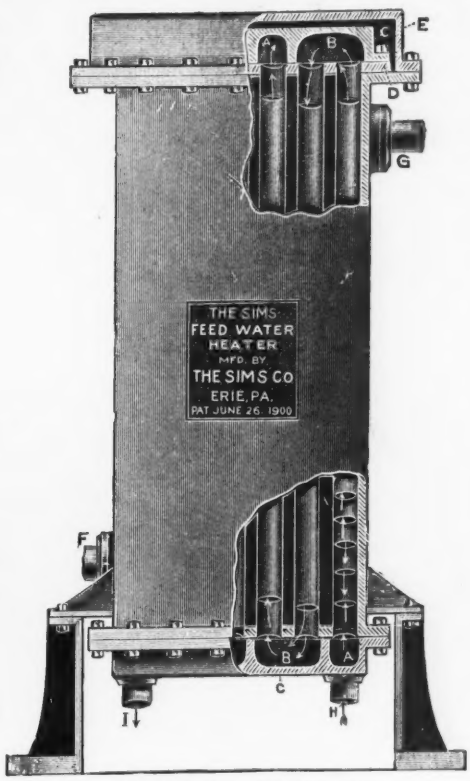
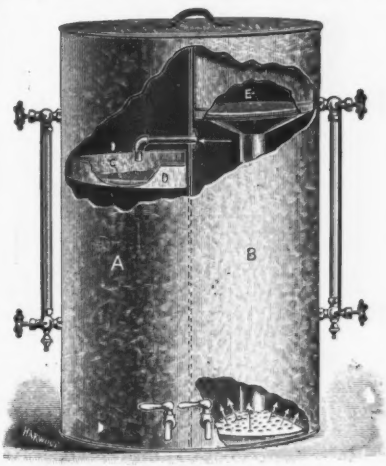


VERTICAL HEATER

The only feed water heater that has perfect circulation of feed water through every tube at the same time, constructed so the tube can be readily scraped.

This is the Oil Filter you require if you want the best results at lowest cost—

The "SIMS" Filter



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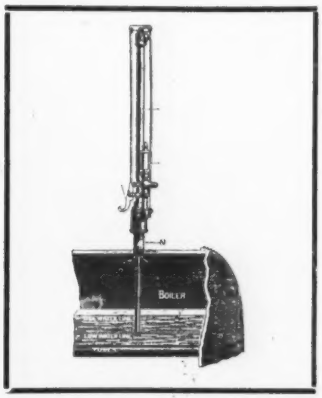
The "SIMS" Low Water Alarm



A SAMPLE ORDER AFTER MONTHS OF COMPETITION WITH OTHER ALARMS

ELLSWORTH, PA., Sept. 5th, 1903.

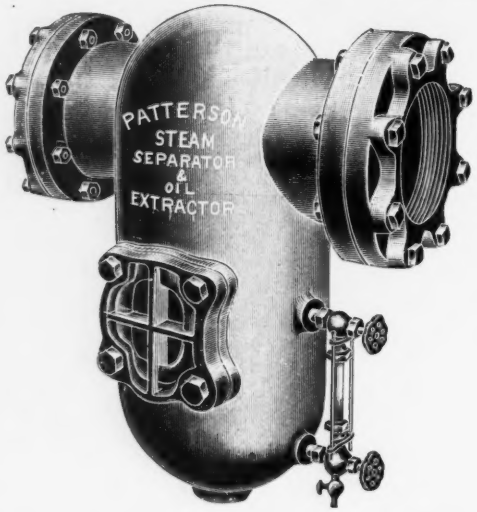
THE SIMS CO., Erie, Pa.,
Gentlemen:—

We have tested your alarms and find same quite satisfactory, and enclose herewith an order for thirty (30). You understand that you have to furnish us with (29) more and render us the bill for the whole thirty. We shall be glad if you will dispatch the same as soon as possible.

And oblige yours truly
JAMES W. ELLSWORTH & Co.

PATTERSON Steam Specialties

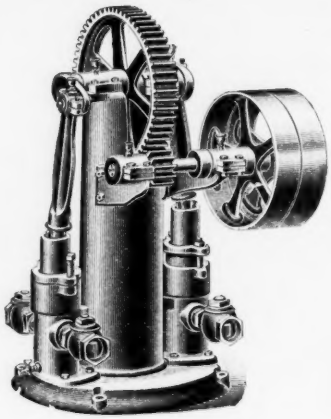
Are All Sold on Thirty Days' Trial, to Be Returned at Our Expense if Unsatisfactory

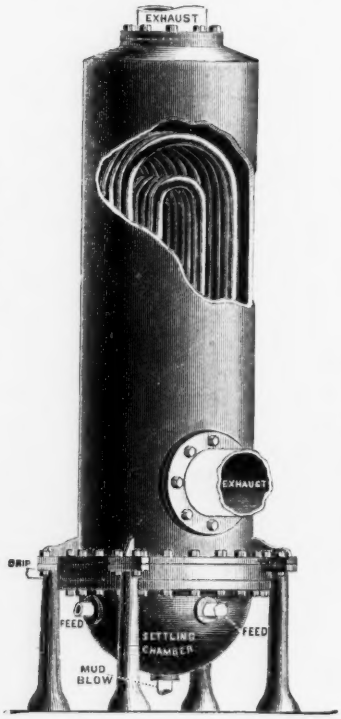


The interior construction and operation of our separators are described in the October issue of THE PRACTICAL ENGINEER, but we can't help again reminding you of that large hand hole for inspection and cleaning without disconnecting the pipes.

DID you ever consider how extravagantly steam pumps use steam? The power required to run a belt pump would hardly be missed.

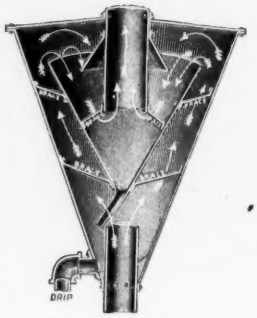
These are simple, strong and very reasonable in price.





The sales of the Patterson-Berryman Feed Water Heater and Purifier keep right on increasing.

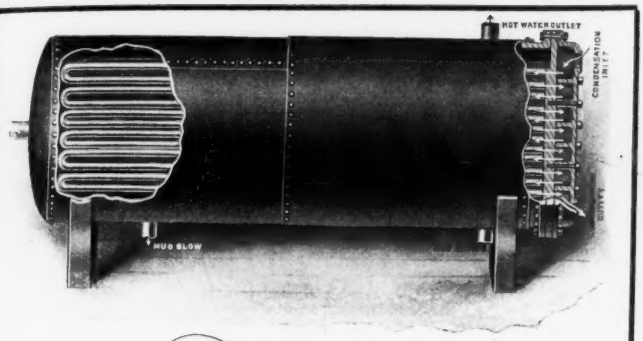
It's the old stand-by. No oil in the boilers, no trouble of any kind. You can't afford to experiment, even if the other fellow's is a little bit cheaper (at first) than this famous little fuel saver.



Are you tired of the way that exhaust pipe is spattering greasy water over everything, including your clothes? Perhaps the neighbors are too. If a Patterson Exhaust Head won't stop the trouble, don't pay us a cent for it.

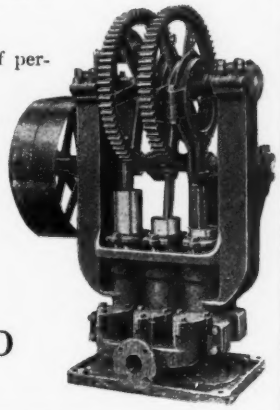
Frank L. Patterson & Co.

24 Cortlandt Street, New York



THE GLEANER
TRADE MARK

The **Gleaner** represents the acme of perfection in feed water heating.



The Davis Triplex Power Pump

is a perfect type of the vertical triplex belt driven pump.

Manufacturers of
The "Berryman" Feed Water Heater and Purifier

I. B. DAVIS & SON
HARTFORD, CONN.

WRITE FOR CATALOGUE, ETC., TO
THOS. McADOO
125 NORTH 4TH ST.
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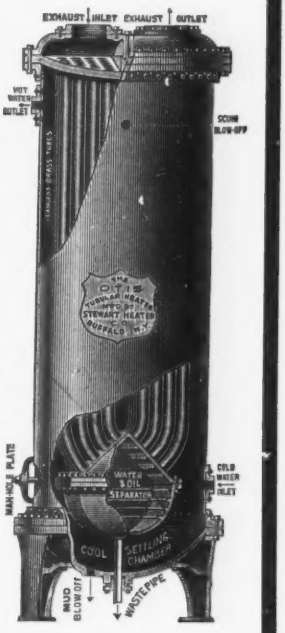
The OTIS Tubular Feed Water Heater, Oil Separator and Purifier

with Seamless Brass Tubes



Guaranteed

To heat the feed water to the boiling point (210 or 212 degrees) with the exhaust steam without causing any back pressure, **also to extract the oil from the exhaust,** so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the additional expense of an eliminator.

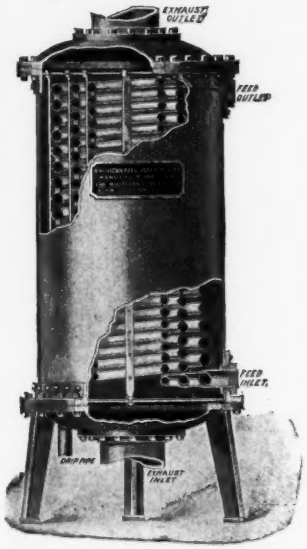
A Liberal Offer

If this heater fails to give satisfaction in every respect, we pay freight, cartage, etc., both ways.

The Stewart Heater Co.

11 Norfolk Ave., Buffalo, N. Y., U. S. A.

The American Standard Copper Coil Feed Water Heater



Simplicity!
Strength!
Economy!
A Money Saver!

It gives so little trouble that one of our customers, who has used one for 8 years, had forgotten that he had it when we asked him the other day how it was doing. He called in the engineer, who said it hadn't been touched since it was put in and was still heating the water to 210 degrees.

That's the kind of a Heater you want.

Write for Catalogue No. 100 P.

The Whitlock Coil Pipe Co.

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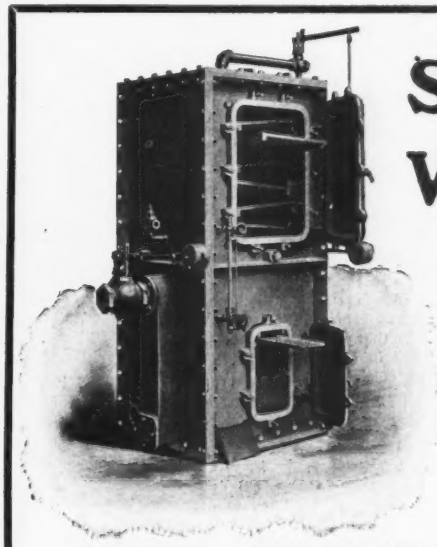


Saving Water

Fresh water for steam boilers not only costs money to heat, but in cities the cost of water itself is an important item.

WEBSTER FEED-WATER HEATERS AND PURIFIERS

utilize all available drips from drying kilns, heating coils, etc., which are suitable for boiler feed or other purposes, and thus automatically save water as well as heat. Their economy of both is remarkable.

Ask the best engineers, and send for booklet.

Warren Webster & Co.

CAMDEN, N. J.

UTILITY STEAM SPECIALTIES

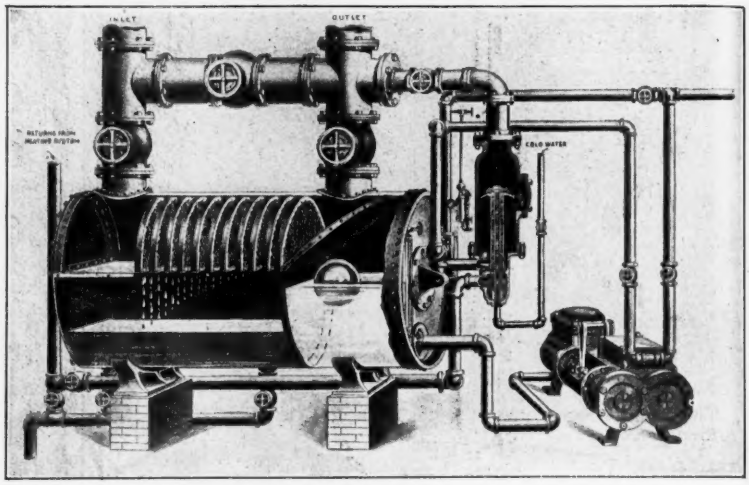
WE POINT TO WHAT
WE'VE DONE AS PROOF
THAT OIL CAN BE ENTIRELY
REMOVED FROM EXHAUST STEAM
AND THAT FEED WATER CAN BE HEATED
ABOUT TO THE TEMPERATURE OF THE EXHAUST

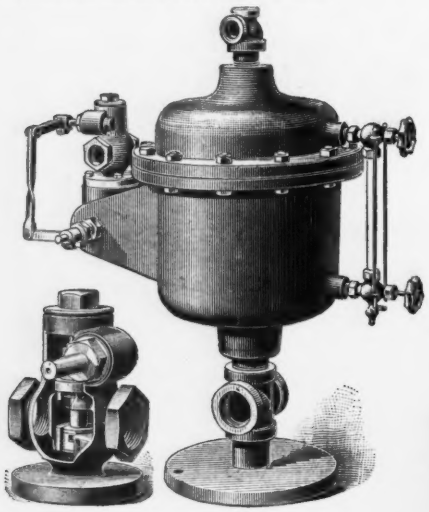
BY

OUR "UTILITY" COMBINATION

We can always guarantee an elimination of 98% at the outlet point of separator. We average over 99% and have in some cases left but $\frac{1}{10800}$ of 1% of oil in the water. You can't see this amount, you can't taste it; fresh well water frequently has more oil in it, and this water can be used for fifty years in boilers without showing a trace of oil deposit. The feed water heating feature is optional but very efficient, free from back pressure and requires but little room and no floor space.

The "Utility" Combination serves as Exhaust Muffler, Oil Separator, Return Tank, Pump Governor and Feed Water Heater. It costs only about as much as a Feed Water Heater.





"UTILITY" PUMP GOVERNOR

The best Pump Governor on the market. Why? Because our valve will not leak or stick, we guarantee it to absolutely govern the pump and remain tight for five years. Compare the construction of our valve with any other on the market. By adopting the "Utility" you can save coal and get a higher temperature from your heating or drying systems. Send for catalogue and list of users.

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STEAM SEPARATOR

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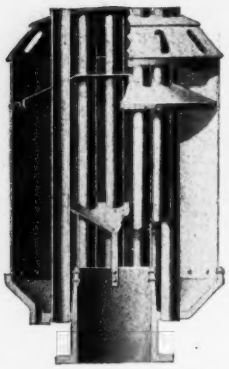
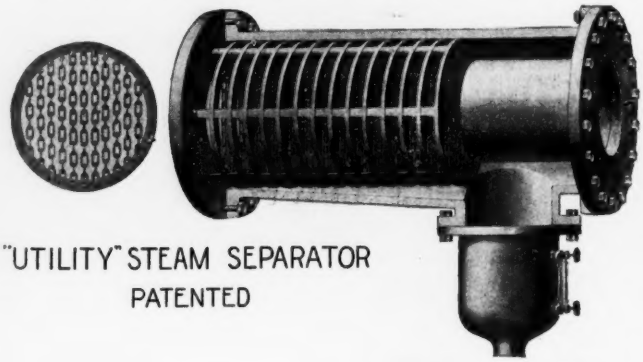


UTILITY EXHAUST HEAD
PATENTED



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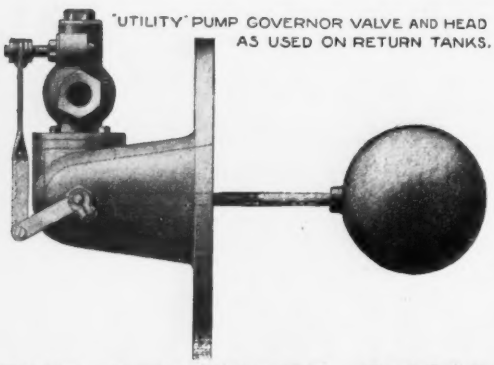
is our new Exhaust Head. Notice the great radiating surface that is given by the CIRCULATING AIR TUBES. These act as condensers, and they lessen instead of causing back pressure. Do you realize that a thousand gallons of water are wasted in a moderate sized plant which lacks an efficient exhaust head? It's so.



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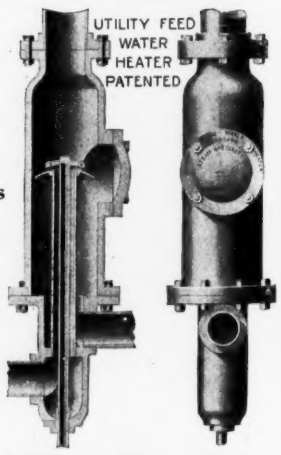
- **Steam Traps**
- **Damper Regulators**
- **Feed Water Controllers**
- **"Utility" Beam Clamps**



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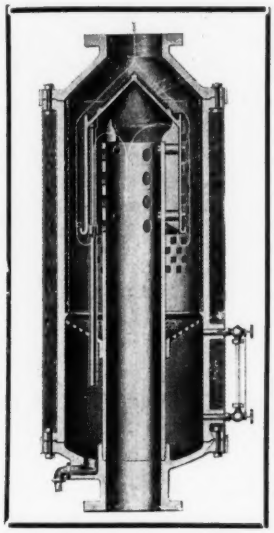

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Our oil separators remove 99% of the oil.

We can prove they do it and give good reasons why.

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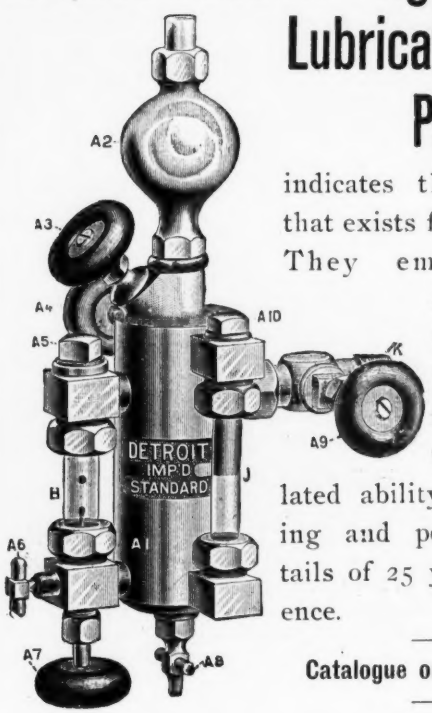

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Horizontal Style for Live Steam or Oil Service

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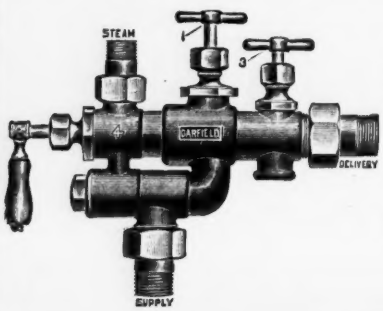

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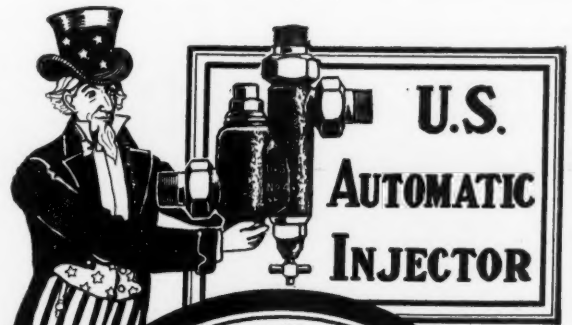

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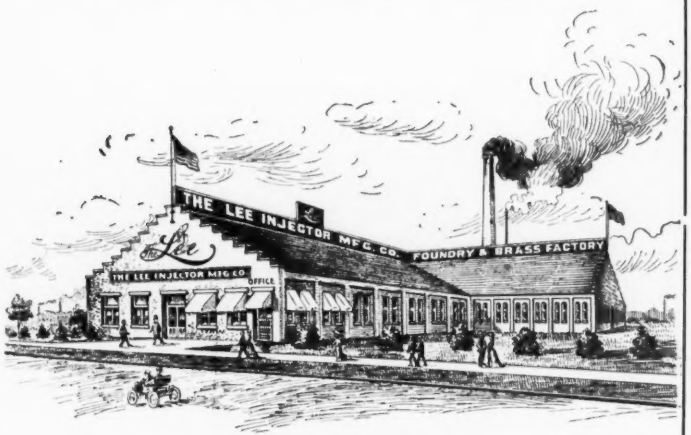

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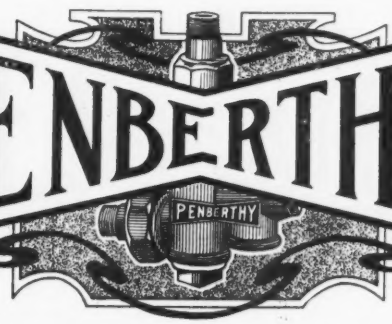

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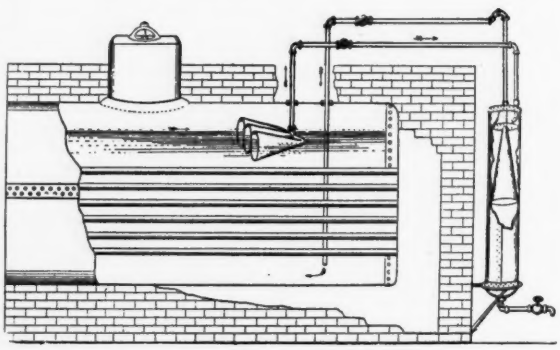
WILL REMOVE ALL OLD SCALE.

WE DO NOT USE COMPOUNDS OR CHEMICALS OF ANY KIND.



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WILL LET YOU RUN WITHOUT A SHUT DOWN FOR A YEAR AT A TIME.

WILL CLEAN YOUR BOILER AND KEEP IT CLEAN AUTOMATICALLY.

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NEVER CEASES TO CLEAN AND DON'T REQUIRE A CORPS OF MEN WITH PICKS TO HELP IT DO THE WORK.

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Keystone Grease is simply grease—pure and unadulterated, it is suitable for any kind of machinery and will reduce friction lower and keep the bearings in better condition than any oil, lubricating compound or other grease made.

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One pound will last longer than four gallons of high grade oil or from three to five pounds of any other grease made.

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Keystone Lubricating Co.

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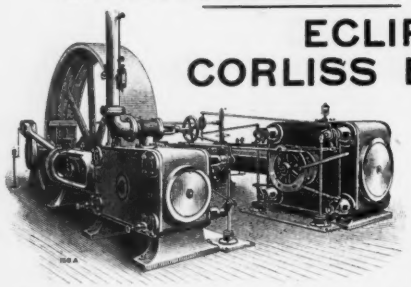

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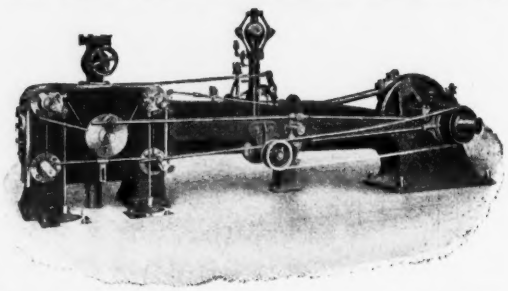

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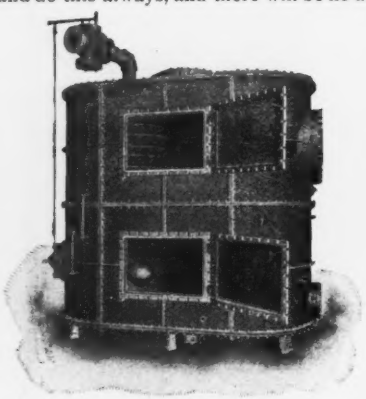

It will give all the purification obtainable with exhaust steam, saving the exhaust in doing the heating, saving the returns and live steam drips and giving purification in other ways.

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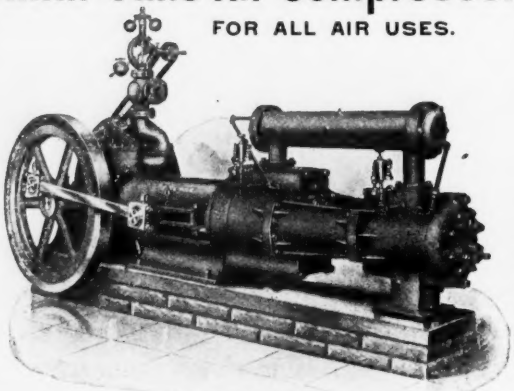

Made in straight line and Duplex types; single and multiple stage Compression · steam or belt driven.

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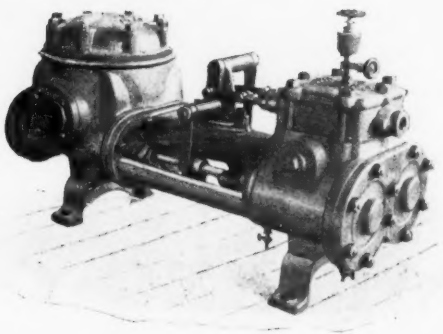

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Write for further details, we can supply your wants.

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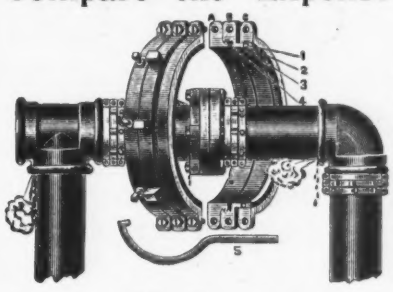
Compare the Expense



By repairing your leaks with the **Climax Steam Joint Clamp** over tearing down the pipe and making the joint new—then order the clamp which is guaranteed to **Stop the Leak**—from your supply house or

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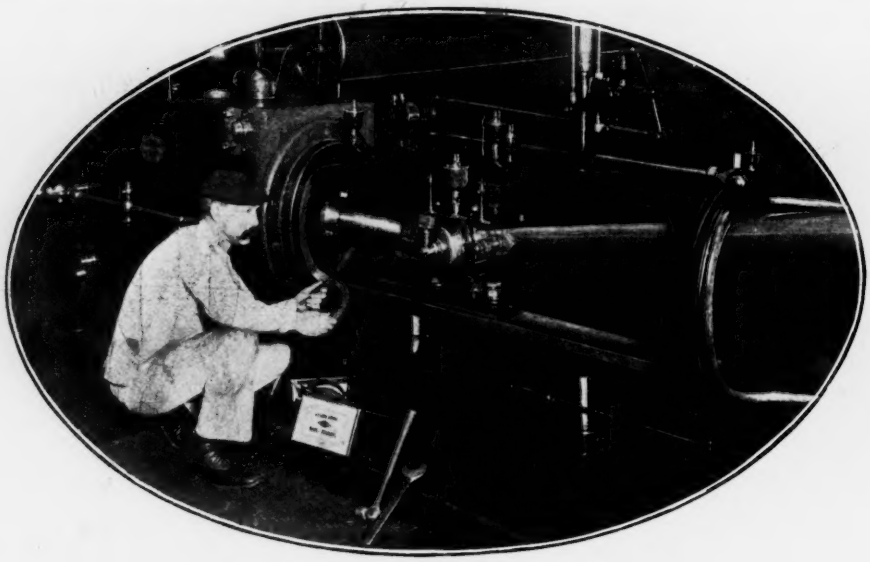

This man is a progressive and economical engineer. His plant, which was designed by himself, is a model of modern engineering skill, and the cost of operation is reduced to a minimum. He has used many different makes of packing, but he says that the best results are obtained with

Garlock High Grade Packings

We manufacture a hundred different styles of packings and gaskets for every known condition. Garlock High Pressure Ring Packing, No. 200, is the best fibrous packing made for high speed and high pressures, and for rods running in oils, grease or chemicals.

Garlock Wire Inserted Sheet Packing is different from any other and much better. We guarantee perfect satisfaction or no pay.

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JOINTS MADE WITH SEARCHLIGHT ARE NOT DISPLACED BY THE VIBRATION OF THE STEAM-LINE

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REPUBLIC IRON & STEEL COMPANY
Blast Furnace and Bessemer Department
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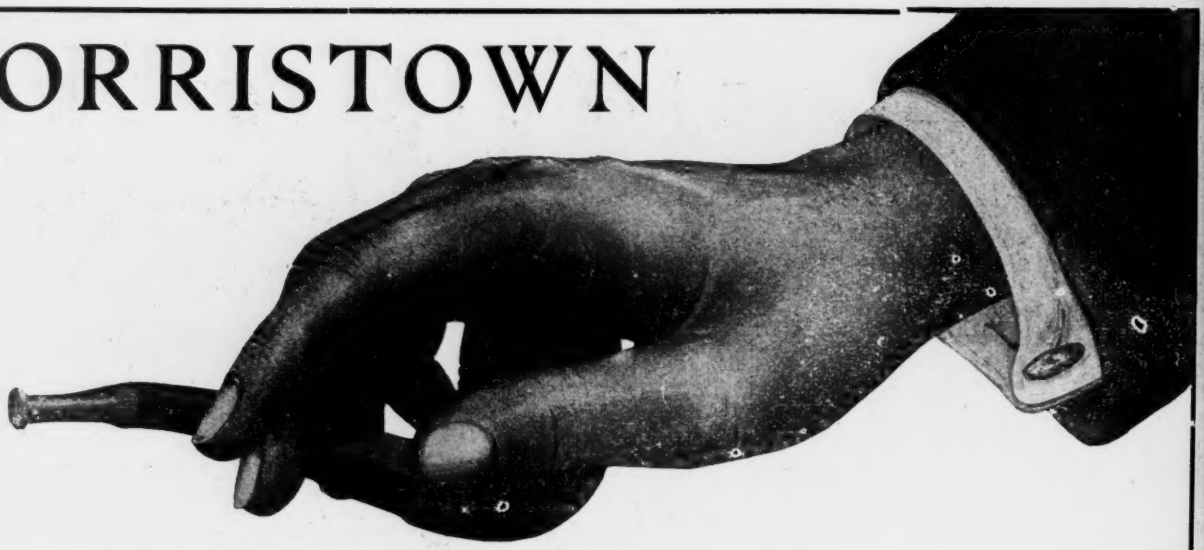

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An Engineer wandered from the straight and narrow path and found himself in the empty coal bin. Looking over the golden gates into the valley below he saw through the thickening mists a veiled figure of marvelous beauty beckoning to him. Come, she said, and dwell in the land of dreams where all is "Radium" and flowers and care never enters. But he hesitated and turned to a fairy queen for advice; Nay, nay, said the fairy, that is "Condensation," who would lure you to ruin. Her land of dreams will be short lived.

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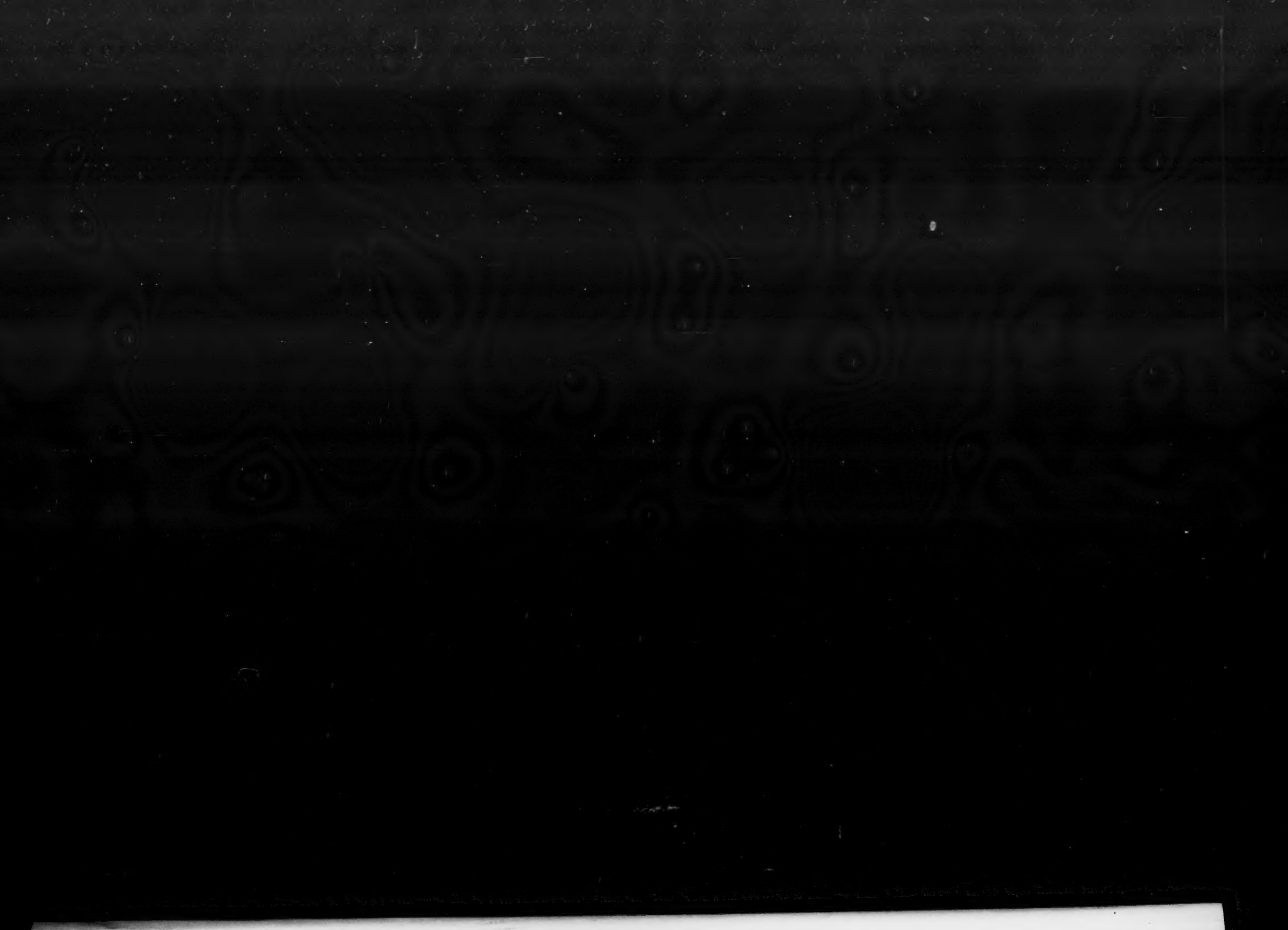
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